ARKANSAS

REASONABLY FORESEEABLE DEVELOPMENT SCENARIO FOR FLUID MINERALS

Prepared for:

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
EASTERN STATES
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The Bureau of Land Management is responsible for the stewardship of our public lands. It is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people for all times. Management is based on the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. These resources include air, fish and wildlife, minerals, paleontological relics, recreation, rangelands, scenic scientific and cultural values, timber; water, and wilderness.

BLM/ES/PL-08/XXX

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ACRONYMS

ACEC	Area of Critical Environmental Concern
AOGC	Arkansas Oil and Gas Commission
APD	Application for Permit to Drill
AU	Assessment Units
BCF	billion cubic feet
BLM	Bureau of Land Management
BOPD	barrels of oil per day
CBNG	Coal Bed Natural Gas
EIS	Environmental Impact Statement
EOR	Enhanced Oil Recovery
ESA	Endangered Species Act
EIS	Environmental Impact Statement
AOGC	Arkansas Oil and Gas Commission
JFO	Jackson Field Office
MMBO	million barrels of oil
ROD	Record of Decision
RMP	Resource Management Plan
SMA	Surface Management Agency
TCF	trillion cubic feet
TPS	Total Petroleum Systems
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey

Summary

Oil was discovered in Arkansas in a well near Stephens in Ouachita County in April of 1920. During the same month, gas was discovered in the northern part of the present El Dorado field in Union County by the Constantin Oil and Refining Company. On January 10, 1921, oil was discovered in the S. T. Busey well in the same field. This marked the beginning of commercial oil production in Arkansas.

Areas within the State of Arkansas that are considered to have high potential for oil and gas occurrence today are located within the West Gulf Costal Plain and the Arkansas Valley (Figure 1). The West Gulf Costal Plain area contains oil and gas reserves, while the Arkansas Valley area contain coal bed natural gas (CBNG) and natural gas reserves in various formations including the Atoka-Desmoinesian Fluvial-Deltaic and Shelf Sandstone, Atoka Deep-Water Sandstone, Morrowan Shallow-Marine Sandstone and Limestone, and Arbuckle through Misener Basement Fault and Shelf. The Fayetteville shale contain one of the most active gas producing regions in Arkansas, and is recognized as one of the largest natural gas producing regions in Arkansas.

Historically, the West Gulf Costal Plain areas have experienced the majority of drilling and development activity in Arkansas. For the 2007 production year Arkansas produced 131,886,153 MCF of gas and 3,094,816 barrels of oil.

Natural gas and oil prices are currently over $8/mcf and $100/bbl, respectively; both values are considerably higher than they have historically been. The DOE EIA predicts a decrease in both prices over the next 10 years. If this comes to pass, this would likely result in slightly slower development than if current high price trends continue.

Within Arkansas it was estimated that approximately 11,730 new oil and gas wells could be drilled in the next 10 years, with 2,524 of these wells producing from Federal (BLM-administered) minerals. Of these approximately 24 would be Coalbed Natural Gas (CBNG), 270 deep gas and 2,230 horizontal shale gas.

The disturbances for the RFD scenario over the next 10 years have been calculated and are displayed in Tables 16 and 17. Table 16 address the disturbances from exploration and construction activities for types of gas wells anticipated to be developed in the northwest central portion of the state. Estimates for horizontal gas and deep gas, CBNG and multiple horizontal wells from single pads as well as horizontal CBNG wells have been extrapolated. The total disturbances for all predicted gas wells are estimated at 63,993 acres. Disturbance from federal mineral development would be 15,076 acres of which 13,517 acres would be on USFS lands. The remaining federal disturbance (1,559 acres) would be on military sites, national park lands, and USFWS refuges. The disturbance to state and fee lands would be 1,039 acres and 52,517 acres respectively.

Table 17 depicts the residual disturbance by well type remaining after appropriate mitigation measures and site restoration or rehabilitation activities have taken place. The total residual disturbance from anticipated development activities is 22,006 acres of which 4,832 would be from federal mineral development. The federal disturbances would affect 4,331 USFS acres and 500 acres of various surface agencies. State and fee residual disturbance would be 331 and 16,844 acres respectively.

The mitigation of initial exploration and construction disturbances would equal nearly 47,339 acres. Mitigation measures would account for remediation of 10,244 federal acres, 699 state acres, and 35,673 fee acres.

1.0 INTRODUCTION

The Bureau of Land Management's Jackson Field Office is located in Jackson, Mississippi, and is responsible for 11 southern states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. The Jackson Field Office manages approximately 34.25 million acres of federal mineral estate in the eastern portion of the United State. Of this approximately 2.4 million mineral estate acres are located in Arkansas where oil and gas leases are active in the Ozark National Forest, Blue Mountain Lake COE, and Fort Chaffee.

The Reasonable Foreseeable Development Scenario (RFDS) forecasts fluid mineral exploration, development, and production for the planning area for the next 10 years. The RFDS assumes a baseline scenario in which no new policies are introduced and all areas not currently closed to leasing and development are opened for oil and gas activity.

Interagency Reference Guide - Reasonably Foreseeable Development Scenarios and Cumulative Effects Analysis for Oil and Gas Activities on Federal Lands in the Greater Rocky Mountain Region" (USDI 2002), "Policy for Reasonably Foreseeable Development Scenario (RFD) for Oil and Gas (BLM WO IM No. 2004-089) and Planning for Fluid Minerals Supplemental Program Guidance (BLM Handbook H-1624-1) guided the criteria and analyses methods used in this RFD.

1.1 Discussion of Determining Oil and Gas Resource Potential

Potential accumulations of oil and gas are described in Section 2. Non-BLM land within the state may be included in this section when it provides a better understanding of resource potential on BLM property. These determinations were made using the geologic criteria provided by reference in Section 2. Also contained in Section 2 are descriptions of stratigraphy, structure, historic oil and gas activities, as well as relevant studies done in the area. Potential reservoir rocks, source rocks, and existing stratigraphic and structural traps are discussed in detail.

1.2 Methodology for Predicting Future Oil and Gas Exploration and Development Activity

Section 7 predicts the type and intensity of future oil and gas exploration and development activities. These forecasts are determined by an area's geology, and historical and present activity, as well as factors such as economics, technological advances, access to oil and gas areas, transportation, and access to processing facilities. Economics, technology, and other factors may be hard to predict because of their complex nature and rapid rate of change. Projections of oil and gas activities are based upon present knowledge. Future changes in global oil and gas markets, infrastructure and transportation, or technological advancements, may affect future oil and gas exploration and development activities within the state.

1.3 Relating the Potential for Resource Occurrence to Potential for Activity

Predicted oil and gas activity does not necessarily correlate with geologic potential for the presence of hydrocarbons. Although the geology of an area may suggest the possibility of oil and gas resources, actual exploration and development may be restricted by high exploration costs, low oil and gas prices, or difficulty accessing the area due to lease stipulations. Thus a small area may have a high resource potential, yet have a low exploration and development potential due to severe restrictions on access. Conversely, technological advancements or an increase in oil and gas prices could result in oil and gas activities in areas regarded as having low potential for occurrence.

2.0 DESCRIPTION OF THE GEOLOGY OF ARKANSAS

Physiographically, Arkansas can be divided by a diagonal line trending northeast to southwest across the state which separates the Interior Highland region in the north, and northwestern part of the state from the Gulf Coastal Plain region located in the southern and eastern part of the state. The Interior Highland region is further subdivided from north to south into the Ozark Plateau, the Arkansas Valley, and the Ouachita Mountains. While the Gulf Coastal Plain, located generally in the southern and eastern part of the state, is divided into two local physiographic regions which include the Mississippi Alluvial Plain and the Western Gulf Coastal Plain. The Mississippi Alluvial Plain is located along the eastern side of the State and the West Gulf Coastal Plain is located along the southern part of the State (*see Figure 1: Physiographic Map of Arkansas*). Paleozoic rocks are exposed in the Interior Highlands region, while the Gulf Coastal Plain area has younger Mesozoic and Cenozoic sediments exposed at surface. These younger sediments on lap the older Paleozoic rocks and unconformably overlie them. The Cenozoic sediments are much more prevalent than the Mesozoic aged rocks, which outcrop in a relatively small area in the southwestern part of the State. (*see Figure 2: Geologic Map of Arkansas*)

Figure 1: Physiographic Map of Arkansas

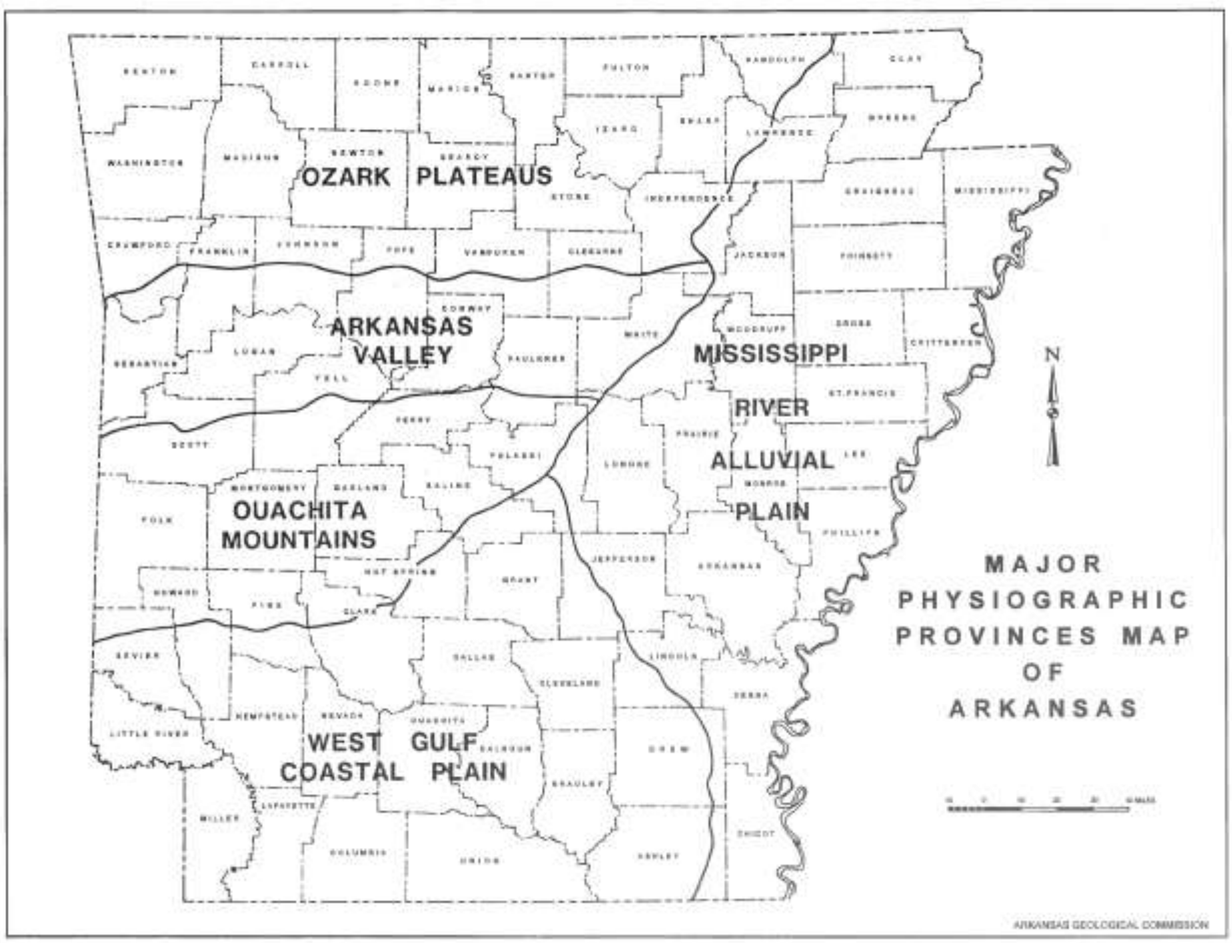

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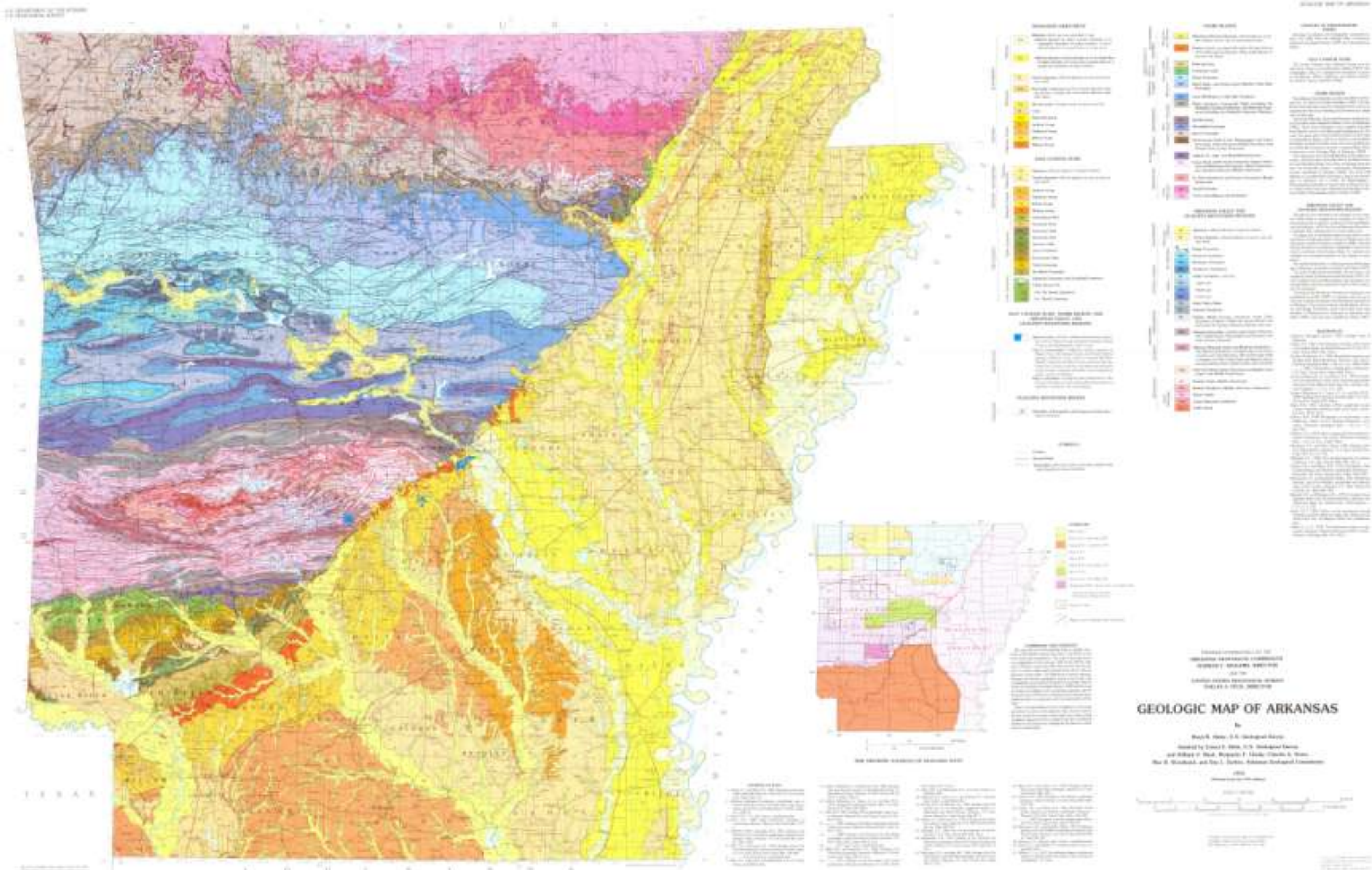
Figure 2: Geologic Map of Arkansas



Arkansas Geologic Commission and USGS, 1993

The region in which the Paleozoic rocks are exposed in northwestern Arkansas can be subdivided into three areas that include: the Ozark Uplift, the Arkoma Basin, and the Ouachita Mountain-Folded Belt. The most northerly of these, located in extreme northern Arkansas, is the Ozark Uplift. The pre-Pennsylvanian rocks that outcrop in this area represent the southern flank of this extensive domal feature the apex of which is located in south-central Missouri. The Arkoma Basin which extends from east to west across the middle of the Paleozoic outcrop area lies to the south of the southern flank of the Ozark Uplift and to the north of the Ouachita Mountain-Folded Belt. This elongated sedimentary basin is both a structurally low area as compared to the adjoining uplift and folded belt and a topographically low area. The Ouachita Mountain-Folded Belt area includes folded and thrust faulted Mississippian and Pennsylvanian aged rocks at the surface with a central core area of exposed older Paleozoic rocks ranging in age from Devonian to Cambrian-Ordovician. At the surface this folded belt vanishes to the south below the Mesozoic aged sediments of the upper Western Gulf Coastal Plain and to the east it is overlapped by Tertiary sediments of the Mississippi Alluvial Plain (Landes K., 1970).

The surface geology of the Mesozoic and Tertiary aged rocks exposed in the Western Gulf Coastal Plain and the Mississippi Alluvial Plain is less complex than that of the Paleozoic area. In the area of Mesozoic (Cretaceous) exposures the rocks are tilted to the south and in the area of Tertiary exposures the rocks dip generally to the southeast in the direction of the Mississippian Embayment the axis of which is near the current course of the Mississippi river on long the eastern border of the State (Landes K., 1970).

2.1 Subsurface Stratigraphy and Structure

The subsurface stratigraphy and structure related to the occurrence of fluid mineral resources for Arkansas is divided into three primary areas or sub-provinces which include: the flank areas of the Ozark uplift in northwest and northern Arkansas; the general area of the Arkoma Basin/Ouachita Mountain-Folded Belt located in northwest and west-central Arkansas; and the area underlying the Gulf Coastal Plain of southern Arkansas.

2.1.1 Ozark Uplift Sub-province

The Ozark Plateau represents the surface expression of the southern flank of the domed Ozark uplift which, as previously noted, is centered in south-central Missouri. At the southern most edge of this feature in northern Arkansas the regional structural dip which is to the south increases gradually into the adjoining Arkoma basin. Some faulting is recognized with normal faults trending mostly northeast – southwest and northwest – southeast which is consistent with similar features in the Arkoma basin, (Adler, F. J. et al, 1971).

Scattered small gas fields have contributed limited amounts of dry gas production from fields in this sub-province in northwestern Arkansas. Production has come from formations of Late Mississippian to Middle Ordovician age and from Pennsylvanian, Mississippian and Devonian aged reservoirs closely associated with the northernmost portions of the adjoining Arkoma basin.

2.1.2 Arkoma Basin/Ouachita Mountain Folded Belt Sub-province

The Arkoma Basin/Ouachita Mountain Folded Belt are two distinct features included here in one general discussion due to their close geographic proximity and related geology.

The Arkoma basin is an elongate east – west sedimentary basin extending from east-central Oklahoma into Arkansas. It includes the McAlester Basin of Oklahoma, and in Arkansas it is generally coincident with the Arkansas River Valley physiographic region although it is not completely restricted to that valley (AGC, web, 2007). The basin is asymmetrical with the deepest part along the southern margin in the area adjacent to the Ouachita Mountain Folded Belt (Branan, C.B., 1968). The basin is dominated by clastic sediments deposited on the margin of a continental shelf with the thickest accumulation of sediment occurring during the deposition of the Pennsylvanian Atoka formation (AGC, web 2007; and Branan, C.B., 1968).

A general stratigraphic column for northern and west central Arkansas including the Ozark Uplift area and the Arkoma Basin / Ouachita sub-province is shown in Figure 3. As indicated the sedimentary rock units present in the subsurface or exposed at surface in this area range in age from Cambrian to Pennsylvanian. Those horizons which represent subsurface reservoirs within these sub-provinces are highlighted.

Structurally the area of the Arkoma basin is made up of numerous broad synclines with intervening generally narrow anticlines (AGC, web, 2007). The axes of these folds typically trend east-west with many being faulted parallel to the axis of the folds. Most of the faulting is normal but some thrusts faults are present and associated with the anticlines in the southern part of the sub-province immediately adjacent to the folded Ouachita Mountain area (AEC, web 2007 and Adler, F. J. et al, 1971)). Folding noted in this southern part of the basin is generally tighter than those found on the northern flank and have steeper structural dip associated with the limbs of the folds. The magnitude of faulting also generally increases from north to south across the basin (Branan, C.B., 1968).

The Arkoma Basin is essentially a dry gas sub-province. The primary conventional gas producing horizons are Pennsylvanian aged reservoirs of the Atoka and Morrow. With deeper horizons from Mississippian through Middle Ordovician aged reservoirs contributing to the conventional gas resource base for the area. Those older reservoirs include the Wedington Sand, Sylamore Sand, the Hunton, the Viola, and the St. Peter Sandstone (AOGC, 1995). Trapping mechanisms include structural, stratigraphic and combination traps. Pennsylvanian and Pre-Pennsylvanian reservoirs in established fields remain as targets for infill drilling and for extensions to those fields (Bengal, 2007, Wolf Exploration, 2007).

The AGC reports that the Arkansas portion of the Arkoma basin contains 104 gas fields with 99 of these fields having active production. The AGC further estimated that during the first 10 months of 2006 annual gas production from conventional gas reservoirs in those fields was 150,879,199 MCF (AGC, web, 2007).

In addition to these conventional reservoirs recent exploration plays in the Arkoma have included an increased interest in unconventional gas reservoir targets that include coal bed methane gas from the Pennsylvanian Hartshorne interval and shale-gas from the Mississippian Fayetteville Shale interval (AGC, web, 2007). Production attributable to the Fayetteville Shale play for the first 10 months of 2006 has been estimated to be 9,729,454 MCF of gas.

In contrast to the Arkoma Basin the Ouachita Mountains/Folded Belt located immediately to the south is a complexly folded and thrust faulted positive structural feature. While the stratigraphic section is similar to that of the adjoining Arkoma basin rocks of Mississippian age and older form the core area of the Ouachita sub-province and are intensely folded and faulted. Strata with potential as reservoir are generally assumed to be rare because of the highly faulted nature of the local structure and because of the effect that weak to low grade metamorphism has had in reducing the original porosity and permeability of the rocks (Adler, F. J. et al, 1971). No oil or gas production has been established to date in the Arkansas portion of the Ouachita area although asphaltic deposits have in the past been exploited (Ratchford, 2007). Large

Figure 3: Stratigraphic Column - Northern and West-Central Arkansas

SYSTEM	SERIES	GROUP	FORMATION	MEMBERS
Pennsylvanian	Desmoinesian		Hartshorne *	
	Atoka *	Upper Atoka *	Carpenter "A" *	
			Upper Alma *	
			Middle Alma	
			Lower Alma *	
			Lower Carpenter *	
		Middle Atoka *	Glassey	
			Casey *	
		Lower Atoka *	Dunn *	
			Barton *	
			Spiro *	
			Basal Atoka *	
	Morrow Group *		Bloyd Shale *	Kestler Lst; Brentwood Lst *
			Hale*	Prairie Grove Cane Hill
Mississippian	Chesterian		Pitkin *	
			Fayetteville Sh.*	Wedington Sst. *
			Batesville Sst.	
			Moorefield *	
			Boone *	St. Joseph
Devonian			Chattanooga Sh. *	
			Sylamore Sst.*	
Silurian	Upper	Hunton*	Penters Chert *	
	Middle		Lafferty Lst. *	
			St. Clair Lst. *	
	Lower		Brassfield Lst.	
Ordovician	Upper	Viola*	Fernvale Lst.	
	Middle		Kimmswick Lst.	
		Simpson*	Plattin	
			Joachim	
			St. Peter Sst. *	
			Everton *	
	Lower	Arbuckle*	Powell Dol.	
			Cotter	
			Jefferson City	
			Roubidoux	
			Casconade / Van Buren	
Cambrian	Upper		Eminence Dol.	
			Bonneterre Dol.	
			Lamotte Sst.	
Pre-Cambrian				

* Indicates horizon or stratigraphic equivalent is a productive reservoir(s)
Source: Bartberger C.E., Dyman T.S., and Condon S.M., 2003; Cambre et al, 1981; and Landes K., 1970.

areas of this region remain relatively unexplored and untested.

Table 1 provides data relative to active and inactive oil and gas fields located in northern Arkansas and includes fields located in the Ozark Uplift and Arkoma/Ouachita Mountain Folded Belt sub-provinces. The vast majority of the fields in this part of Arkansas are classified as having non-associated gas present with oil and associated-dissolved gas being absent.

2.1.3 Gulf Coastal Plain Sub-Province

The Gulf Coastal Plain sub-province is located south of the Ouachita Mountain – Folded Belt and extends across southwestern and south central Arkansas. The rock units exposed at surface are not well consolidated and include sandstones, shale, and evaporites. These sediments range in age from Cretaceous to Pleistocene (*see Figure 2 Arkansas Geologic map*). At surface the rocks are tilted very slightly to the south and southeast with dip rates in the order of 80 to 100 feet per mile.

A generalized stratigraphic column for southern Arkansas is shown in Figure 4. As indicated the sedimentary rock units present in the subsurface in this area range in age from Triassic to Tertiary. Those horizons which represent subsurface reservoirs within this sub-province are highlighted.

While strong folding is generally absent normal faults are common in the subsurface and trend west -east with the down thrown side to the south. Oil production with some associated gas was first established in this sub-province nearly ninety years ago and is found in association with these features in structural, stratigraphic and combination traps (AGC, web, 2007).

Secondary and tertiary recovery operations have been common for many years. In this very mature sub-province, infill drilling, as well as enhanced oil recovery efforts, have been the basis of continued production of oil for sometime (Bengal L, 2007, and Wohlfordf C., 2007).

Table 2 provides data relative to active and inactive oil and gas fields located in southern Arkansas and includes fields located in the Gulf Coastal Plain sub-province. In contrast to the northern part of the state, the majority of the fields in this part of Arkansas are classified as having oil present, and non-associated gas and associated-dissolved gas being generally absent.

Table 1: Active and Inactive Oil and Gas Fields - Northern Arkansas

FIELD NAME	COUNTY NAME	TYPES
AETNA	CRAWFORD, FRANKLIN, JOHNSON, & LOGAN	N
ALBION	WHITE	N
ALIX	FRANKLIN	N
ALMA	CRAWFORD & SEBASTION	N
ALMA DEEP	CRAWFORD	N
ALMA EAST	CRAWFORD	N
ALMA NEW	CRAWFORD	N
ALMA NORTH	CRAWFORD & FRANKLIN	N
ALMA SHALLOW	CRAWFORD	N
ALTUS	FRANKLIN & JOHNSON	N
B-43	CONWAY, FAULKNER, VAN BUREN, & WHITE	N
BALDWIN	WASHINGTON	N
BARNEY	FAULKNER	N
BATES	SCOTT	N
BATSON	FRANKLIN & JOHNSON	N
BENTON	BENTON	N
BEVERLY	FRANKLIN & SEBASTIAN	N
BEVERLY BARTON	FRANKLIN	N
BLAIR CREEK	WASHINGTON	N
BLAIR CREEK SOUTH	WASHINGTON	N
BLICK	CONWAY	N
BLOOMER	SEBASTIAN	N
BONANZA	SEBASTIAN	N
BOOGER HOLLOW	POPE	N
BOONEVILLE	FRANKLIN, LOGAN, & SEBASTIAN	N
BRENTWOOD	WASHINGTON	N
BROCK CREEK	LOGAN	N
CANNON CREEK	FRANKLIN & MADISON	N
CARROLTON DOME	BOONE	N
CAULKSVILLE	FRANKLIN & LOGAN	N
CECIL	CRAWFORD, FRANKLIN, LOGAN, MADISON, & SEBASTIAN	N
CENTER	FRANKLIN	OA
CENTERTON	BENTON	N
CENTER RIDGE	CONWAY	N
CHAFFEE ARKOMA UNIT	YELL	N
CHAMBERS	SEBASTIAN	N
CHARLESTON	FRANKLIN & LOGAN	N
CHISMVILLE	LOGAN	N
CLARKSVILLE	JOHNSON	N
CLARKSVILLE (NEW)	JOHNSON	N
CLAY	WHITE	N
CLINTON NE	VAN BUREN	N
CNR HARTFORD	SEBASTIAN	N
COAL HILL	FRANKLIN & JOHNSON	N

FIELD NAME	COUNTY NAME	TYPES
COVE CREEK	FAULKNER & VAN BUREN	N
CYPRESS VALLEY	CONWAY	N
DEAN SPRINGS	CRAWFORD	N
DELAWARE	LOGAN	N
DOVER	POPE	N
DRIPPING SPRINGS	CRAWFORD	N
DYER	CRAWFORD & FRANKLIN	N
EAST CUTTHROAT	WHITE	N
EWING	SEBASTIAN	N
EWING (NEW)	CRAWFORD & SEBASTIAN	N
EWING DEEP	SEBASTIAN	N
EXCELSIOR	SEBASTIAN	N
FERN SPRINGS	FRANKLIN	N
FLETCHER CREEK	LOGAN	N
FRIENDSHIP CHURCH	WASHINGTON	N
FROG BAYOU	CRAWFORD	N
FURGERSON	POPE	N
GOOSE CREEK	WASHINGTON	N
GRAGG	FRANKLIN, LOGAN & SEBASTIAN	N
GRAVEL HILL	CONWAY & VAN BUREN	N
GREENBRIER	FAULKNER	N
GREENWOOD	SEBASTIAN	N
GREENWOOD JUNCTION	CRAWFORD	N
GRIFFIN MOUNTAIN	CONWAY	N
HACKETT	JOHNSON & SEBASTIAN	N
HAGARVILLE	JOHNSON	N
HARDT	WASHINGTON	N
HARTFORD	SEBASTIAN	N
HARTMAN	JOHNSON	N
HAZEL VALLEY	WASHINGTON	N
HECTOR	POPE	N
HECTOR EAST	POPE	N
HIGH OCEAN	WASHINGTON	N
HOLLIS LAKE	CRAWFORD & SEBASTIAN	N
HUNT	JOHNSON	N
HUNTSVILLE	MADISON	N
HURRICANE CREEK	CRAWFORD	N
IONE	LOGAN	N
JERUSALEM	CONWAY & POPE	N
JERUSALEM EAST	CONWAY	N
JETHRO	CONWAY & FRANKLIN	N
KIBLER	CRAWFORD	N
KIBLER DEEP	CRAWFORD	N
KIBLER SHALLOW	CRAWFORD	N
KIBLER-WILLIAMS	CRAWFORD, FRANKLIN & SEBASTIAN	N
KNOXVILLE	JOHNSON, LOGAN, & POPE	N

FIELD NAME	COUNTY NAME	TYPES
LAVACA	SEBASTIAN	N
LAVACA DEEP	SEBASTIAN	N
LAVACA SHALLOW	SEBASTIAN	N
LEE CREEK	CRAWFORD	N
LETONA	WHITE	N
LICK MOUNTAIN	CONWAY	N
LINVILLE	JOHNSON	N
LITTLE CREEK	WHITE	N
LOCKE	CRAWFORD & FRANKLIN	N
LONE ELM	CRAWFORD & FRANKLIN	N
LOW GAP	JOHNSON	N
LUDWIG	JOHNSON	N
LULA DELON	SEBASTIAN	N
LUTHERVILLE	JOHNSON	N
MAGAZINE	LOGAN	N
MAGNOLIA	MADISON	OA
MANSFIELD	LOGAN, SCOTT, & SEBASTIAN	N
MARTINVILLE	FAULKNER	N
MASSARD	CRAWFORD, LOGAN, & SEBASTIAN	N
MASSARD DEEP	CRAWFORD & SEBASTIAN	N
MASSARD PRAIRIE	SEBASTIAN	N
MIKES CREEK	JOHNSON	N
MINERAL SPRINGS	WASHINGTON	N
MORELAND	POPE	N
MT NEBO	LOGAN & YELL	N
NATURAL DAM	CRAWFORD	N
NEW HOPE	POPE	N
NEW QUITMAN	CLEBURNE & FAULKNER	N
OAK GROVE	POPE	N
OLD COAL HILL	JOHNSON	N
OLD HICKORY	CONWAY	N
OZARK	FRANKLIN	N
OZARK DEEP	FRANKLIN	N
OZARK SHALLOW	FRANKLIN	N
OZONE	JOHNSON	N
PARADISE	FRANKLIN	N
PARIS	FRANKLIN, JOHNSON, & LOGAN	N
PEARSON	CLEBURNE	N
PETER PENDER	FRANKLIN & SEBASTIAN	N
PINE RIDGE	LOGAN	N
PINEY CREEK	CLEBURNE	N
POSSUMTROT	FRANKLIN	N
PRAIRIE VIEW	LOGAN	N
QUITMAN	CLEBURNE	N
RENA	CRAWFORD	N
RHEA	WASHINGTON	N

FIELD NAME	COUNTY NAME	TYPES
RICH HOLLOW	WASHINGTON	N
RICH MOUNTAIN	LOGAN	N
ROCK CREEK	FRANKLIN & JOHNSON	N
ROSS	CRAWFORD, JOHNSON, & POPE	N
RUDY	CRAWFORD	N
SCOTLAND	VAN BUREN	N
SCOTTSVILLE	POPE	N
SCRANTON	JOHNSON & LOGAN	N
SECTION TEN	CRAWFORD	N
SHIBLEY	CRAWFORD & LOGAN	N
SHIBLEY SE	CRAWFORD	N
SILEX	JOHNSON & POPE	N
SKYLIGHT MOUNTAIN	WASHINGTON	N
SLAYTONVILLE	SEBASTIAN	N
SMOKEY ROAD	CONWAY	N
SPADRA	CRAWFORD, JOHNSON, & LOGAN	N
SPIRIT LAKE	JOHNSON	ONA
SPRING BRANCH	JOHNSON	OA
ST VINCENT	CONWAY	N
SUGAR GROVE	LOGAN	N
SUGAR HILL	WASHINGTON	N
SUNSET	WASHINGTON	N
TATES ISLAND	POPE	N
TUCKS CHAPEL	BENTON	N
UNION CITY	JOHNSON & LOGAN	N
URSULA	FRANKLIN & SEBASTIAN	N
VESTA (NEW)	FRANKLIN	N
VESTA (OLD)	FRANKLIN	N
WATALULA	FRANKLIN	N
WAVELAND	LOGAN & YELL	N
WEBB CITY	FRANKLIN	N
WEDINGTON	WASHINGTON	N
WEST FORK	WASHINGTON	N
WHITE OAK	FRANKLIN	N
WHITE ROCK MOUNTAIN	FRANKLIN	N
WILLIAMS	CRAWFORD	N
WILLIAMS DEEP	CRAWFORD	N
WILLIAMS SHALLOW	CRAWFORD	N
WINSLOW	WASHINGTON	N
WITCHERVILLE	SEBASTIAN	N
WONDERVIEW	CONWAY	N
WYMAN	WASHINGTON	N

ONA = Oil, nonassociated gas, and associated dissolved gas are present.
OA = Oil and associated-dissolved gas present; nonassociated gas absent.
N = Nonassociated gas present; oil and associated-dissolved gas absent.
Source: Arkansas Oil and Gas Commission 2007

Figure 4: Stratigraphic Column - Southern Arkansas

SYSTEM	SERIES		GROUP		FORMATION	MEMBER
Tertiary	Eocene		Jackson (?)			
			Claiborne			
			Wilcox			
	Paleocene		Midway			
Cretaceous	Upper Cretaceous	Gulf	Narvarro		Arkadelphia	
					Nacatoch *	
			Taylor		Saratoga	
					Malbrook	
					Annona	
					Ozan *	Meakin *
						Graves *
			Austin		Browstown	
					Tokio *	(Blossom) *
					Eagle Ford	
					Woodbine (Tuscaloosa) *	
	Lower Cretaceous	Coahuilan - Comanche	Washita - Fredericksburg		Goodland *	
			Trinity		Paluxy *	
				Glenn Rose*	Morningsport *	
					Ferry Lake	
					Rodessa *	Kilpatrick *
					James *	
					Pine Island *	
					Sligo *	(Pettet) *
					Hosston * (Travis Peak) *	
Jurassic	Upper Jurassic		Cotton Valley *		Schuler *	
					Bossier	(Jones) *
					Haynesville *	Buckner
					Smackover *	(Reynolds)*
	Middle Jurassic				Norphlet Shale	
					Louann Salt	
					Werner Anhydrite.	
Triassic	U. Triassic				Eagle Mills	

* Indicates horizon or stratigraphic equivalent is a productive reservoir(s)
Source: Bartberger C.E., Dyman T.S., and Condon S.M., 2003; Cambre et al, 1981; and Landes K., 1970

.

Table 2: Active and Inactive Oil and Gas Fields - Southern Arkansas

FIELD NAME	COUNTY NAME	TYPES
AGNES ROAD	UNION	OA
AGNES ROAD NORTH	UNION	O
ARKANA	LAFAYETTE	OA
ARTESIAN	CALHOUN	O
ARTESIAN EAST	CALHOUN	O
ARTEX	MILLER	OA
ASH BRANCH	UNION	O
ATLANTA	COLUMBIA	OA
ATLANTA EAST	COLUMBIA	OA
AURELLE	UNION	O
BARLOW BRANCH	COLUMBIA	O
BEAR CREEK	UNION	OA
BEECH CREEK	UNION	OA
BEECH CREEK WEST	UNION	OA
BEECH HILL	UNION	O
BENJAMIN LAKE	UNION	O
BERRY	UNION	OA
BERT CREEK	UNION	O
BERT CREEK SOUTH	UNION	O
BETHEL CHURCH	UNION	OA
BETHLEHEM	UNION	O
BIG BRANCH	LAFAYETTE	O
BIG BRANCH EAST	LAFAYETTE	O
BIG CREEK	COLUMBIA	OA
BLOOMBURG	MILLER	OA
BLOOMBURG SE	MILLER	N
BODCAU CREEK	LAFAYETTE	O
BODCAW	NEVADA	O
BODCAW CREEK	LAFAYETTE	O
BOGGY BOTTOM	UNION	O
BOGGY CREEK	MILLER	OA
BOIS D'ARC	HEMPSTEAD	O
BOLDING	UNION	O
BOYCE LAKE	MILLER	OA
BOYD	MILLER	N
BOYD HILL	MILLER	OA
BRADLEY	LAFAYETTE	O
BRADLEY SOUTH	LAFAYETTE	O
BRADLEY WEST	LAFAYETTE	OA
BRAGG	OUACHITA	O
BRISTER	COLUMBIA	O
BRUSHY LAKE	LAFAYETTE	O
BUCKNER	COLUMBIA & LAFAYETTE	OA
BUENA VISTA	OUACHITA	O

FIELD NAME	COUNTY NAME	TYPES
BURDELL BRANCH	NEVADA	O
BURNS POND	UNION	OA
BURNSIDE CREEK	UNION	O
CAIRO	UNION	OA
CAIRO EAST	UNION	OA
CALHOUN	COLUMBIA	OA
CALION	UNION	OA
CALVARY CHURCH	UNION	ONA
CAMP CREEK	UNION	OA
CANFIELD	COLUMBIA & LAFAYETTE	OA
CAREYVILLE LANDING	BRADLEY & UNION	OA
CATESVILLE	UNION	OA
CENTER	OUACHITA	OA
CENTRAL CHURCH	MILLER	O
CENTRAL SCHOOL	MILLER	O
CHALYBEAT SPRINGS	COLUMBIA	OA
CHAMPAGNOLLE	UNION	OA
CHAMPAGNOLLE LANDING	UNION	O
CHARIVARI CREEK	BRADLEY	O
CHICKEN CREEK	MILLER	O
CHICKEN CREEK SW	MILLER	O
CHRISTMAS	MILLER	OA
CLEAR CREEK	LAFAYETTE	O
CLEVELAND BRANCH	LAFAYETTE	O
COLLEGE HILL	COLUMBIA	OA
COLUMBIA	COLUMBIA	OA
CORINTH CHURCH	COLUMBIA	O
CORNIE CREEK	UNION	ONA
CORNISH BRANCH	LAFAYETTE	OA
CRAIG	UNION	O
CRAIN CITY	UNION	O
CROOKED CREEK	COLUMBIA	OA
CROSS COUNTRY SLOUGH	CALHOUN	O
CROSSETT	ASHLEY	O
CUMMINGS	MILLER	OA
CURTIS CREEK	UNION	O
CYPRESS	COLUMBIA	N
CYPRESS CREEK	UNION	OA
CYPRESS LAKE	MILLER	OA
CYPRESS LAKE SOUTH	MILLER	OA
CYPRESS LAKE WEST	MILLER	OA
DAYS CREEK	MILLER	OA
DAYS CREEK SOUTH	MILLER	O
DEWITT BLOCK	ARKANSAS	O
DICKSON ROAD	COLUMBIA	OA
DODDRIDGE	MILLER	O

FIELD NAME	COUNTY NAME	TYPES
DODDRIDGE WEST	MILLER	O
DOOLEY CREEK	LAFAYETTE	O
DORCHEAT	COLUMBIA	OA
DORCHEAT-MACEDONIA	COLUMBIA	OA
DRY CREEK	UNION	O
DRY FORK	LAFAYETTE	O
DUTY	LAFAYETTE	OA
EL DORADO	UNION	OA
EL DORADO EAST	UNION	OA
EL DORADO SOUTH	UNION	OA
ELLIOTT	OUACHITA	OA
ELLIOTT SOUTH	OUACHITA	ON
ENYART LAKE	LAFAYETTE	OA
EVANS	COLUMBIA	OA
EZZELL	UNION	O
FALCON	LAFAYETTE & NEVADA	OA
FELSENTHAL	ASHLEY	O
FIELD BAYOU	LAFAYETTE	OA
FISH LAKE	MILLER	O
FORKY DEER	MILLER	O
FORT LYNN	MILLER	OA
FORT LYNN EAST	MILLER	O
FOUKE	MILLER	ONA
FOUKE NE	MILLER	O
FOUKE NORTH	MILLER	ONA
FOUKE WEST	MILLER	OA
FOUR MILE CREEK	MILLER	OA
FOUR MILE CREEK SOUTH	MILLER	OA
FROG LEVEL	COLUMBIA	OA
GALILEE CHURCH	LAFAYETTE	OA
GARLAND CITY (NEW)	MILLER	OA
GARLAND CITY (OLD)	MILLER	OA
GARNER CREEK	UNION	OA
GENOA	MILLER	OA
GOLD POINT CHURCH	MILLER	OA
GRAVES CREEK	UNION	O
GRAYSON	COLUMBIA	OA
GREEN GROVE	UNION	O
GREERS CHURCH	COLUMBIA	OA
GREGORY	UNION	OA
GUM CREEK	OUACHITA	OA
HAMPTON	CALHOUN	O
HARMONY	COLUMBIA	O
HARMONY GROVE	MILLER	OA
HARPER CREEK	COLUMBIA	OA
HAWKINS CREEK	COLUMBIA	O

FIELD NAME	COUNTY NAME	TYPES
HAYNESVILLE	COLUMBIA	OA
HAYNESVILLE NORTH	COLUMBIA	OA
HENDERSON CREEK	COLUMBIA	OA
HERVEY	MILLER	O
HIBANK	UNION	OA
HIBANK CREEK	UNION	OA
HIBANK SOUTH	UNION	O
HILLSBORO	UNION	OA
HILLSBORO SOUTH	UNION	ONA
HOGG	UNION	OA
HOLLY SPRINGS CHURCH	MILLER	OA
HOLMES CREEK	CLARK & UNION	ON
HOOKER BRANCH	MILLER	OA
HORSEHEAD	COLUMBIA	OA
HORSEHEAD CREEK	COLUMBIA	OA
IRMA	NEVADA	OA
IRON	LAFAYETTE	O
IRONS	LAFAYETTE	O
JENNINGS	COLUMBIA	OA
JONESVILLE	MILLER	O
JUNCTION CITY	UNION	OA
KELLY BAYOU	MILLER	OA
KEOUN CREEK	COLUMBIA & LAFAYETTE	ONA
KERLIN	COLUMBIA	OA
KIBLAH	LAFAYETTE & MILLER	OA
KIBLAH EAST	LAFAYETTE	OA
KIBLER-WILLIAMS	MILLER & OUACHITA	N
KILGORE LODGE	COLUMBIA	O
KRAUSSE HILL	MILLER	O
KRESS CITY	LAFAYETTE	OA
KRESS CITY EAST	LAFAYETTE	O
KRESS CITY SE	LAFAYETTE	OA
KRESS CITY SOUTH	LAFAYETTE	OA
KRESS CITY SW	LAFAYETTE	OA
LAKE ERLING	LAFAYETTE	ONA
LAKE ERLING EAST	LAFAYETTE	O
LAKE ERLING SOUTH	LAFAYETTE	OA
LAKE JUNE	LAFAYETTE	OA
LANEY ROAD	UNION	O
LANGLEY	OUACHITA	OA
LAPILE	UNION	OA
LAPILE EAST	UNION	O
LAWSON	UNION	OA
LAWSON NORTH	UNION	OA
LAWSON SOUTH	UNION	O
LAWSON SOUTH (NEW)	UNION	O

FIELD NAME	COUNTY NAME	TYPES
LENZ	MILLER	O
LEWISVILLE	LAFAYETTE	OA
LEWISVILLE NE	LAFAYETTE	O
LEWISVILLE NORTH	LAFAYETTE	OA
LEWISVILLE NW	LAFAYETTE	O
LEWISVILLE OLD TOWN	LAFAYETTE	OA
LEWISVILLE SOUTH	LAFAYETTE	OA
LEWISVILLE WEST	LAFAYETTE	OA
LIBERTY CHURCH	LAFAYETTE	ONA
LICK CREEK	BRADLEY & UNION	OA
LISBON	UNION	OA
LISBON EAST	UNION	OA
LISBON NORTH	UNION	OA
LISBON NW	UNION	OA
LISBON OLD	UNION	O
LISBON SOUTH	UNION	O
LISBON WEST	UNION	O
LITTLE BODCAW	LAFAYETTE	O
LITTLE CHURCH	MILLER	OA
LLOYD CREEK	CALHOUN	O
LOCUST BAYOU	CALHOUN	O
LOUTRE CREEK	UNION	O
LOWERY BRANCH	UNION	O
MACEDONIA	COLUMBIA	OA
MAGNOLIA	COLUMBIA	OA
MANDEVILLE	MILLER	OA
MARS HILL	LAFAYETTE	OA
MARYSVILLE	UNION	O
MAYTON	MILLER	O
MCDONALD	OUACHITA	O
MCKAMIE NE	LAFAYETTE	O
MCKAMIE PATTON	LAFAYETTE	OA
MCKAMIE SOUTH	LAFAYETTE	ONA
MCKINNEY BAYOU	MILLER	OA
MCLENDON BRANCH	COLUMBIA	OA
MCNATT	NEVADA	O
MCNEIL EAST	COLUMBIA	O
MEDLOCK	COLUMBIA	O
MERIWETHER LAKE	LAFAYETTE	OA
MERIWETHER LAKE SOUTH	LAFAYETTE	O
MIDWAY	LAFAYETTE	OA
MIDWAY EAST	LAFAYETTE	O
MIDWAY WEST	LAFAYETTE	OA
MILL CREEK	UNION	OA
MOCCASIN BAYOU	MILLER	OA
MOHAWK	COLUMBIA	OA

FIELD NAME	COUNTY NAME	TYPES
MOHAWK SW	COLUMBIA	OA
MORO BAY	CALHOUN	O
MT HOLLY	UNION	OA
MT HOLLY EAST	UNION	OA
MT HOLLY NORTH	UNION	OA
MT HOLLY WEST	COLUMBIA	O
MT PLEASANT	LAFAYETTE	O
MT VERNON	COLUMBIA	ONA
MT WILLIE ROAD	UNION	O
MT ZION	UNION	OA
MT ZION EAST	UNION	OA
MUD LAKE	CALHOUN	O
NATIONS CREEK	COLUMBIA	O
NEW LONDON	UNION	OA
NEW LONDON NORTH	UNION	O
NEWELL	UNION	O
NICHOLS	NEVADA	O
NICHOLS HILL	NEVADA	O
NICK SPRINGS	UNION	OA
NICK SPRINGS EAST	UNION	OA
NICK SPRINGS WEST	UNION	OA
NORMAN LAKE	LAFAYETTE	O
NORPHLET	UNION	O
OAKLAND NORTH	UNION	O
OBRIEN	UNION	O
OGEMAW	OUACHITA	O
OLD UNION	UNION	O
OLIN FOREST	UNION	OA
OLIN FOREST NORTH	UNION	OA
PACE CITY	OUACHITA	OA
PACE CITY	UNION	OA
PACE CITY EAST	OUACHITA & UNION	O
PALM	LAFAYETTE	OA
PALM WEST	LAFAYETTE	O
PATMOS	HEMPSTEAD	O
PATMOS NORTH	HEMPSTEAD	O
PATTON	LAFAYETTE	OA
PAUP SPUR	MILLER	OA
PETER PENDER	LAFAYETTE	N
PIGEON HILL	BRADLEY& UNION	O
PILL BRANCH	MILLER	O
PINE TREE	COLUMBIA	OA
PISGAH	COLUMBIA	OA
PLAINFIELD	COLUMBIA	OA
PLEASANT GROVE (NEW)	UNION	O
PLEASANT GROVE (OLD)	UNION	O

FIELD NAME	COUNTY NAME	TYPES
PLEASANT HILL	MILLER	OA
PLEASANT VALLEY	LAFAYETTE	O
PLEASANT VALLEY SOUTH	LAFAYETTE	O
POISON SPRINGS	OUACHITA	O
PROMISED LAND CHURCH	MILLER	O
PRUDHOE BAY	LAFAYETTE	O
PRUDHOE BAY SOUTH	LAFAYETTE	O
RAINBOW SOUTH	UNION	O
RAMSEY CREEK	UNION	O
RAWLS CREEK	LAFAYETTE	OA
RED ROCK	COLUMBIA	OA
RICHLAND CREEK	UNION	O
RILEY BRANCH	COLUMBIA	O
RITCHIE	UNION	OA
RIVER BEND	UNION	O
ROCKY MOUND	MILLER	O
ROCKY MOUND SOUTH	MILLER	ONA
RODESSA	MILLER	ONA
RODESSA NORTH	MILLER	N
RODESSA WEST	MILLER	O
RONDO	MILLER	OA
SALEM CHURCH	COLUMBIA & UNION	ONA
SALEM GRACE CHURCH	LAFAYETTE	OA
SANDY BEND	UNION	O
SANDY BEND NORTH	UNION	O
SANDY CREEK	UNION	O
SAULS CHAPEL	UNION	OA
SCHULER	UNION	O
SCHULER EAST	UNION	O
SEMINARY CHURCH	OUACHITA	O
SHEPHERD	UNION	O
SHEPPARD BRANCH	UNION	O
SHILOH	LAFAYETTE	OA
SHONGALOO NORTH	COLUMBIA	OA
SHORT	UNION	O
SHULER	UNION	OA
SHULER EAST	UNION	OA
SMACKOVER	OUACHITA & UNION	OA
SMITHVILLE	UNION	O
SNOW HILL	OUACHITA	OA
SPADRA	COLUMBIA	N
SPIRIT LAKE	LAFAYETTE & MILLER	ONA
SPIRIT LAKE NORTH	LAFAYETTE	OA
SPOTTSVILLE	COLUMBIA	OA
SPRINGHILL	COLUMBIA & LAFAYETTE	OA
ST JONAH CHURCH	LAFAYETTE	OA

FIELD NAME	COUNTY NAME	TYPES
ST MARY	LAFAYETTE	OA
ST MARY WEST	LAFAYETTE	OA
ST MATTHEWS	COLUMBIA	O
STAMPS	LAFAYETTE	ONA
STAMPS EAST	LAFAYETTE	O
STAMPS NE	LAFAYETTE	O
STAMPS NORTH	LAFAYETTE	O
STAMPS NW	LAFAYETTE	O
STAMPS WEST	LAFAYETTE	O
STATE LINE	UNION	O
STATELINE	UNION	OA
STATELINE SW	UNION	O
STEPHENS	COLUMBIA, NEVADA, OUACHITA, & UNION	OA
STEPHENS NORTH	NEVADA	O
STEPHENS NORTH EXTENSION	OUACHITA	O
STOW LAKE	UNION	O
STRONG	UNION	OA
STRONG NORTH	UNION	ON
SULPHUR RIVER	MILLER	OA
SUNVIEW(NEW)	LAFAYETTE	O
SUNVIEW(OLD)	LAFAYETTE	O
TEXARKANA	MILLER	ONA
TEXARKANA EAST	MILLER	O
THREE CREEKS	UNION	OA
THREE CREEKS EAST	UNION	O
TOM CREEK	UNION	O
TROY	NEVADA	OA
TROY EAST	OUACHITA	O
TROY NORTH	NEVADA	OA
TROY WEST	NEVADA	O
TRULL	UNION	O
TUBAL	COLUMBIA	ONA
TUBAL	UNION	ONA
TURKEY CREEK	UNION	OA
URBANA	UNION	OA
URBANA WEST	UNION	O
VILLAGE	COLUMBIA	OA
WALDO	COLUMBIA	O
WALKER CREEK	COLUMBIA & LAFAYETTE	OA
WALNUT HILL	LAFAYETTE	OA
WARE CREEK	COLUMBIA	OA
WARNOCK SPRINGS	COLUMBIA	OA
WARNOCK SPRINGS EAST	COLUMBIA	N
WELCOME	COLUMBIA	OA
WESGUM	OUACHITA	OA
WESSON	COLUMBIA & OUACHITA	OA

FIELD NAME	COUNTY NAME	TYPES
WESSON NORTH	OUACHITA	O
WICKHAM CREEK	UNION	OA
WICKHAM CREEK WEST	UNION	O
WILDWOOD	UNION	O
WILKS	UNION	OA
WILLISVILLE	NEVADA	O
WILLISVILLE SW	NEVADA	O
WILLISVILLE WEST	NEVADA	O
WILMINGTON	UNION	O
WILMINGTON SOUTH	UNION	O
WINCHESTER	UNION	OA
WOODLEY	UNION	O
WOODLEY WEST	UNION	O
WYATT	UNION	O
YOUNG	NEVADA	O

ONA = Oil, nonassociated gas, and associated dissolved gas are present.
ON = Oil and nonassociated gas present; associated-dissolved gas absent.
N = Nonassociated gas present; oil and associated-dissolved gas absent.
O = Oil present; nonassociated gas and associated-dissolved gas absent.
OA = Oil and associated-dissolved gas present; nonassociated gas absent.
Source: Arkansas Oil and Gas Commission 2007

3.0 SUMMARY OF USGS PLAY DESCRIPTIONS FOR THE ARKOMA BASIN PROVINCE

The most recent oil and gas assessment by the USGS for the Arkoma province was completed in 1995. In that assessment of the entire province which includes parts of both Arkansas and Oklahoma eight conventional gas plays and one conventional oil play were assessed. Those included a Hinterland Oil Play, an Atoka-Desmoinesian Fluvial-Deltaic and Shelf Sandstone Gas Play, an Atoka Deep-Water Sandstone Gas Play, a Morrowan Shallow-Marine Sandstone and Limestone Gas Play, an Arbuckle through Misener Basement Fault and Shelf Gas Play, a Cromwell-Spiro-Wapanucka Sub-Choctaw-Thrust Gas Play, a Carboniferous Turbidite Thrust-Belt Gas Play, a Lower Paleozoic through Mississippian Eastern Arkoma Gas Play, and a Morrowan Clastic Wedge Gas Play. The Hinterland Oil Play and the Cromwell-Spiro-Wapanucka Sub-Choctaw-Thrust Gas Play are located mainly in the Oklahoma portion of the province with little to no potential for development in Arkansas. The Lower Paleozoic through Mississippian Eastern Arkoma Gas Play and a Morrowan Clastic Wedge Gas Play are located entirely in the Arkansas part of the province. The remainder of the listed plays has varying degrees of geographic extent in Arkansas.

The following is a summary of those plays which have some level of impact for potential exploration and production in Arkansas and includes information concerning the play concept, source rocks and reservoirs, and exploration status and resource potential that existed at the time of the assessment was conducted by the USGS. The primary source material for this summary presentation is the USGS 1995 Oil and Gas Assessment, *Geologic Report, Arkoma Basin Province* by William, J. Perry Jr., 1995. This summary section is divided into two sub-sections which are:

- Identified play areas exclusive to Arkansas portion of the Arkoma Province
- Identified play areas which are located in both the Arkansas and Oklahoma portions of the portion of the Arkoma Province

3.1 Identified Play Areas Exclusive to Arkansas Portion of the Arkoma Province

3.1.1 Lower Paleozoic through Mississippian Eastern Arkoma Gas Play (Hypothetical)

<u>Play Concept</u>: This play is based on the proposition that thermal maturities in eastern portions of the basin that are projected to lower than those noted in central Arkansas makes it possible for a gas accumulation of the minimum size (6 BCFG) to be present in reservoir quality rocks of the Lower Paleozoic through Mississippian. The play includes the eastern Arkoma Basin and parts of the adjacent Mississippi embayment.

<u>Reservoirs and Source Rocks</u>: Potential reservoirs include Lower Paleozoic through Devonian carbonate rocks and Middle Ordovician St. Peter Sandstone. Organic-rich Devonian and Mississippian shales present to the southwest of the play area are considered the possible source rocks.

<u>Traps</u>: The trapping mechanism is projected to be structural.

<u>Exploration status and resource potential</u>: At the time of the assessment very little exploration had taken place along the eastern margin of the Arkoma Basin. This play was at that time given a 0.08 probability of containing an accumulation of minimum size (6 BCFG). That probability was based on the low probabilities of trap retention and anticipated problems related to the richness of the source rock, timing of the reservoir charge and overmaturity of the source rock.

3.1.2 *Morrowan Clastic Wedge Gas Play (Hypothetical)*

Play Concept: This hypothetical gas play is based on the supposition that prodelta and offshelf turbidite sands equivalent to the Morrowan sands of the southern Illinois Basin could be present along the eastern edge of the Arkoma Basin. The area of the play includes the easternmost Arkoma Basin and adjacent Mississippi embayment south of the northern pinchout of the Mississippian section.

Reservoirs and Source Rocks: Possible reservoir rocks include sandstones that are equivalent to the sands of fluvial-deltaic origin present the southern Illinois Basin. Upper Mississippian and Lower Pennsylvanian organic-rich shales are considered possible source rocks for the play.

Traps: Trapping mechanisms for the play are assumed to be both structural and stratigraphic.

Exploration status and resource potential: At the time of the assessment very little exploration had taken place along the eastern margin of the Arkoma Basin. This play was given a 0.04 probability of containing an accumulation of minimum size (6 BCFG). Anticipated problems associated with this play included problems related to reservoir charge, the lack of documentation for reservoir occurrence, and the probable low potential for trap retention.

3.2 Identified Play Areas Located in Both the Arkansas and Oklahoma Portions of the Arkoma Province:

3.2.1 *Atoka-Desmoinesian Fluvial-Deltaic and Shelf Sandstone Gas Play*

Play Concept: At the time of the assessment this play covered an area of some 9,900 square miles mi and included 46 gas fields in the northern and central part of the Arkoma Basin. The basal Atokan part of the play represents south-to southeast-trending fluvial-deltaic sands in channels that were down cut into the underlying Morrowan deposits. These sands were subsequently overlain by sheet sandstones. The Upper Atokan shallow-water sheet sandstones are a shallow shelf sequence which is overlain by fluvial-deltaic Desmoinesian aged sandstones which prograded into the basin from east to west and then north to south.

Reservoirs and Source Rocks: Reservoirs include basal and Upper Atokan sand reservoirs as well as Desmoinesian aged sandstones. The range of reservoir properties identified for these rock units are shown in Table 3 below:

Table 3

Reservoir Properties

RESERVOIR	DEPTH RANGE	NET PAY	POROSITY	PERMEABILITY
Desmoinesian Sands	1,185 to 3,326 ft	8 to 162 ft	10-18 %	6 to 850 mD
Upper Atoka Sands	1,958 to 5,120 ft	16-55 ft	10-17.5 %	
Basal Atoka Sands	2,775 to 12,000 ft	15 to 55 ft	9 to 17.5 %	10 to21 mD

Source rocks for this play include shales in the lower part of the Atoka and older Paleozoic shales of Mississippian and Upper Devonian to Mississippian age.

Traps: Trapping mechanisms are combination, structural and stratigraphic. A number of the established fields in this play particularly in the eastern portion of the basin are located on anticlines or along down-to-basin normal faults.

Exploration status and resource potential: The first and largest gas field discovered in this play is the Kinta field of Oklahoma. This field, discovered in 1910 had produced more than 1,440 BCFG from shallow-marine and fluvial Atokan sandstones and more than 40 BCFG from Desmoinesian sandstones through August, 1992. At the time of the 1995 assessment the probable number of accumulations yet to be discovered in this play area was estimated to be 10.

3.2.2 Atoka Deep-Water Sandstone Gas Play

Play Concept: This confirmed conventional gas play includes fields in both Oklahoma and Arkansas. The Atoka Formation which is approximately about 1,500 ft thick near the northern edge of the Arkoma basin thickens to more than 18,000 ft thick near the southern edge of the basin adjacent to the Ouachita front. Most of this thickening is within the middle Atoka interval and represents a slope facies containing lenticular sand bodies elongated parallel to and downthrown to faults developed contemporaneous to deposition. It is proposed that sand deposition occurred in slope channels localized by rapid subsidence close to the downthrown side of these faults.

Reservoirs and Source Rocks: Middle Atokan sandstones represent the reservoirs for this play. Depths in existing fields range from 4500 to more than 11,500 ft. The range of reservoir properties include: net pay from 11 to 75 ft; porosity from 12 to 20 percent, and permeability from 10 to 174 mD, Source rocks are inferred to include deeper water Atokan and possibly Morrowan and Springer equivalent shales

Traps: Traps are combination, structural and stratigraphic. Many of the existing fields, in this play particularly in the eastern portion of the play area are on anticlines or along the down-to-basin normal faults.

Exploration status and resource potential: As of 1992 deep-water Atokan sandstones had produced more than 1,810 BCFG from gas fields within the play area. At the time of the 1995 assessment the probable number of accumulations of more than 6 BCFG producible gas yet to be discovered in this play area was estimated to be 4.

3.2.3 Morrowan Shallow Marine Sandstone and Limestone Gas Play

Play Concept: This play is a confirmed conventional gas play which includes Morrowan accumulations with gas production reported from 40 fields in the central and western Arkoma Basin. In the Arkansas portion of the play area, stacked sequences of Morrowan shallow-marine gas-bearing sandstone (Hale Formation) and interbedded shale are present. This sequence appears to be the result of numerous minor sea level fluctuations or other pulse-like changes in sediment supply.

Reservoirs and Source Rocks: In Arkansas, the sandstone reservoirs are less calcareous and are commonly developed on faulted anticlines at depths of from 1,735 to more than 8,000 ft with a reported porosity ranging of from 7 to 15 percent. Source rocks are inferred to include organic-rich Morrowan shales, dark-gray deeper water shales of Mississippian age and possibly Upper Devonian to Mississippian Woodford Shale.

Traps: Traps are and dominantly structural in Arkansas where fracture-enhanced porosity is suspected and combination structural and stratigraphic to the west in the Oklahoma portion for the basin.

Exploration status and resource potential: As of 1992 Morrowan shallow-marine sandstones and limestones have produced more than 960 BCFG in the play area. At the time of the 1995 assessment the probable median number of accumulations yet to be discovered within this play area was estimated to be 5.

3.2.4 Arbuckle through Misner Basement Fault and Shelf Gas Play

Play Concept: This play is a confirmed conventional gas play that is principally structural in nature and involves Cambrian through Devonian aged shelf rocks beneath and north of the front of the Ouachita Fold and Thrust Belt. The play area includes the central and western Arkoma Basin as well as basement structures beneath the frontal Ouachita Thrust Belt.

Reservoirs and Source Rocks: Reservoirs are principally Arbuckle and Hunton carbonates but may include some sand units of the Simpson and Misener. The erosion at the top of the underlying Arbuckle may be associated with the development of a thick zone of karstic porosity in the upper Arbuckle. This component of the play may not be thoroughly tested, particularly in Arkansas. Depths to the reservoirs in this play are in the range of 5800 to more than 14,000 ft. Source rocks include the Woodford Shale and possibly shales of the Ordovician section.

Traps: Traps identified are mainly structural. These include fault blocks bounded by steep down-to-south normal faults, or paleo-topographic features developed at the top of the Hunton Group.

Exploration status and resource potential: At the time of the 1995 assessment it was estimated that at least three new gas fields of at least minimum size remained to be discovered in this play area. It was further suggested that the probable median undiscovered field size would be about 50 BCFG.

3.2.5 Carboniferous Turbidite Thrust-Belt Gas Play (Hypothetical)

Play Concept: This hypothetical conventional gas play postulates possible gas accumulations of more than 6 BCFG in Mississippian and Pennsylvanian predominantly sandstone reservoirs in thrust-fault-related structural traps.

Reservoirs and Source Rocks: Reservoirs include Pennsylvanian and Mississippian sandstones, offshelf equivalents of the Morrowan carbonates, Lower Mississippian cherts and Ordovician chert. While reservoir quality is largely unknown it is suspected to decline eastward in the play area. Anticipated reservoir depths may exceed 20,000 ft.

Traps: Thrust fault structural traps are suggested as the trapping mechanism.

Exploration status and resource potential: No gas fields approaching 6 BCFG have been discovered in this play. At the time of the 1995 assessment it was estimated that the probability of discovering one accumulation of this size in this play area was 0.2.

4.0 PAST AND PRESENT OIL AND GAS EXPLORATION ACTIVITY

4.1 Geophysical and Geochemical Surveys

4.1.1 Geophysical Surveys

Prior to conducting seismic operation as part of any oil and gas exploration effort in Arkansas oil and gas operators must obtain seismic permits from the Arkansas Oil and Gas Commission. Table 4 below provides information as to the number of permits issued by that commission during the last five years. The strong influence of exploration activity in the area of the Fayetteville Shale exploration play is evident in the number of permits issued in that area during the last three years.

Table 4
Permits Issued for Seismic Operations in Arkansas 2003-2007

Location	2003	2004	2005	2006	2007
Fayetteville Shale	0	1	12	20	13
Arkoma Basin	0	1	0	3	0
South Ark.	2	4	3	4	2
Total	2	6	15	27	15

Source: Arkansas Oil and Gas Commission, 2008

4.1.2 Geochemical Surveys

The most recent regional geochemical survey conducted in Arkansas relative to oil and gas exploration was an organic geochemistry and thermal maturation study conducted in the general area of thought to have potential for Fayetteville Shale gas in the Eastern Arkoma Basin and Mississippi Embayment regions. The study highlights areas with potential for production based on geochemical data and also suggests some possible limiting factors for extension of the play in the areas of the Ouachita Thrust belt and portions off the Mississippi embayment (Ratchford, M. Ed, et al, 2006). To date the study has been widely used by exploration companies in focusing exploration efforts for the Fayetteville Shale interval.

4.2 Exploratory Drilling and Success Rates

The success rates are reported from interviews with operators and AOGC staff. The Fayetteville shale play is currently reported as having 100 percent success for completion and a 60 percent economic success rate. The Fairway play is very mature and little activity is taking place other than replacements. The Atoka has been reported as 70 percent success for completions with a 60 percent economic success rate. The southern Arkansas plays are reporting as having a 75 percent success rate for completions and a 75 percent rate for economic success.

4.3 New Field and Reservoir Discoveries

4.3.1 Fayetteville Shale Play:

The Fayetteville Shale is a Mississippian-Chester aged shale which is the stratigraphic equivalent of the Caney Shale found on the Oklahoma side of the Arkoma Basin. Counties in the Arkansas portion of the play from east to west include Phillips, Lee, Monroe, St. Francis, Prairie, Lonoke, Woodruff, Jackson, White, Faulkner, Cleburne, Van Buren, Conway, Pope and Franklin. This unconventional gas reservoir ranges in thickness from 50 to 550 feet and is found at depths of 1,500 to 6,500 feet. The play has been on-going for the past 3 to 4 years with substantial increases in leasing, geophysical and drilling activity across the play area (Bengal, 2007 and Ratchford, 2007). Generally this shale-gas play is a result of the natural gas industry's increased understanding of the nature of shale-gas accumulations combined with technological advances in 3-D seismic evaluation, horizontal drilling and well fracture treatment or stimulation and a strong pricing environment for natural gas.

Figures 5, 6 and 7 are a series of maps prepared by the Arkansas Geological Commission (AGC) that covers the eastern, central and western parts of the play area. These maps provide basic information as to Fayetteville well locations as well as information relative to oil and natural gas transportation and transmission lines and other features.

During the early part of the exploration effort producers were required under the rules and regulations of the Arkansas Oil and Gas Commission to make application to establish field rules for the production of these unconventional reservoirs. As the productive area of the resource began to expand both industry and the regulatory staff of the Commission recognized that the same regulatory approach was applicable across the entire play area and recommended such a standardized approach rather than developing a patchwork of individual field rules for individual areas (Bengal, 2007). In response to that concept, the Arkansas Oil and Commission issued General Rule B 43, which sets up rules for drilling units for both unconventional and unconventional reservoirs in a multi-county area across Arkansas, which is coincident with that area thought to be prospective for Fayetteville shale-gas production. In summary, the rule, a complete copy of which is included in Appendix B of this report, provides for 640 acres drilling units for unconventional reservoir completions, with unit boundary set backs of 560 feet, minimum spacing is set at 560 feet between locations, and a maximum of 16 locations per drilling unit are allowed. (AOGC General Rules and Regulations, 2007). Wells completed in conventional reservoirs, in the area covered under Rule B 43, have different requirements with respect to set back, spacing and the number of wells allowed per unit.

Southwestern Energy Company, a major exploration and production company active in the play, reported 2006 reserves from the Fayetteville to be 300 Bcf of gas and 2006 annual production from this horizon at 11.8 Bcf of gas. As of June 30, 2007, the company had drilled and completed a total of 303 operated wells in the Fayetteville Shale play (Southwest Energy Company Operations Report, 2007).

Cumulative gas production for all rule B-43 wells completed in the Fayetteville interval through September 30, 2007 is in excess 67 Bcf of gas (AOGC, 2007). The AOGC expects to issue approximately 500 drilling permits for this play in 2008 (Bengal, 2007)

Exploration and production practices for the Fayetteville shale-gas play include the following:

- Regional geochemical studies by the AGC has been widely used in focusing drilling operations into areas that have potentially high organic content within the shale and thus greater potential for gas accumulation.
- 3-D seismic operations are routinely conducted prior to drilling operations in an effort to insure that horizontal laterals will not intersect any existing faults. Such intersections could limit the effectiveness of facture treatments / stimulations that are conducted during well completion operations.
- Most wells currently being drilled are being drilled utilizing horizontal drilling methods. Horizontal laterals are 2300 ft to 3000 ft in length. The vertical portion of the well is generally air drilled and the horizontal segment is drilled using a mud rotary system with oil based drilling mud once the Fayetteville section is encountered. The drilling mud is confined in lined pits.

Figure 5

Arkansas Fayetteville Shale Gas Play

East Map

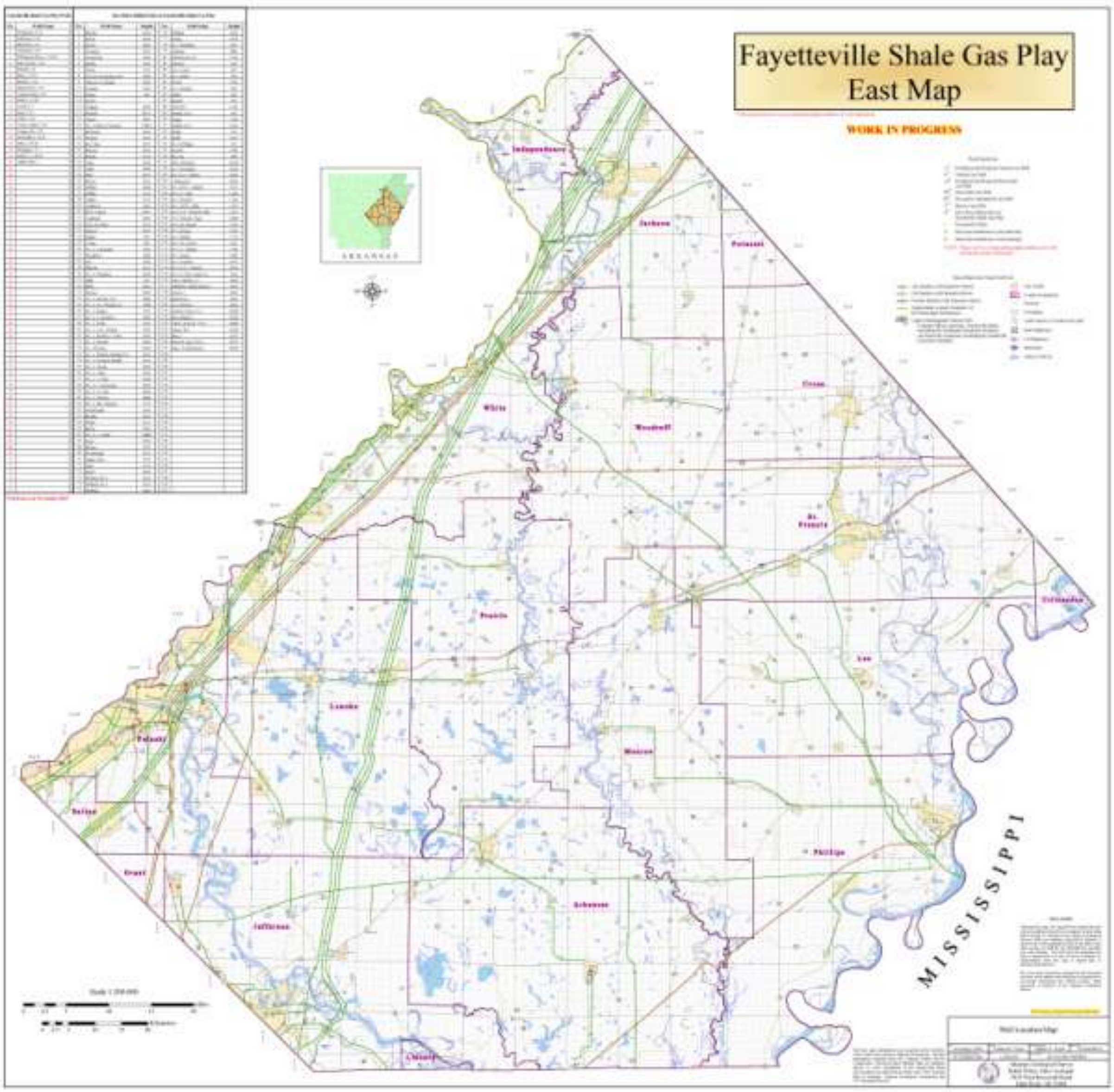


Figure 6

Arkansas Fayetteville Shale Gas Play

Central Map

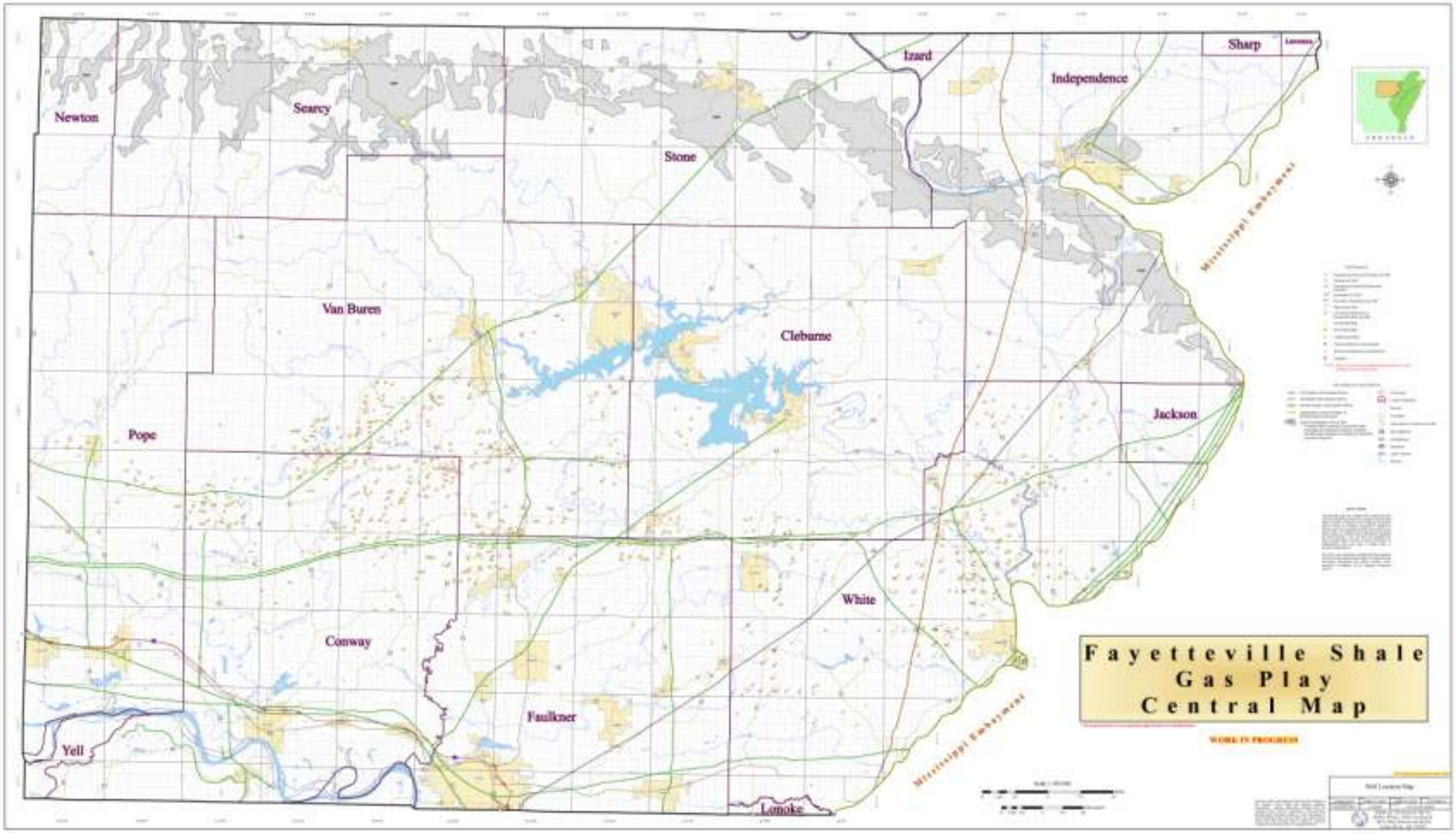
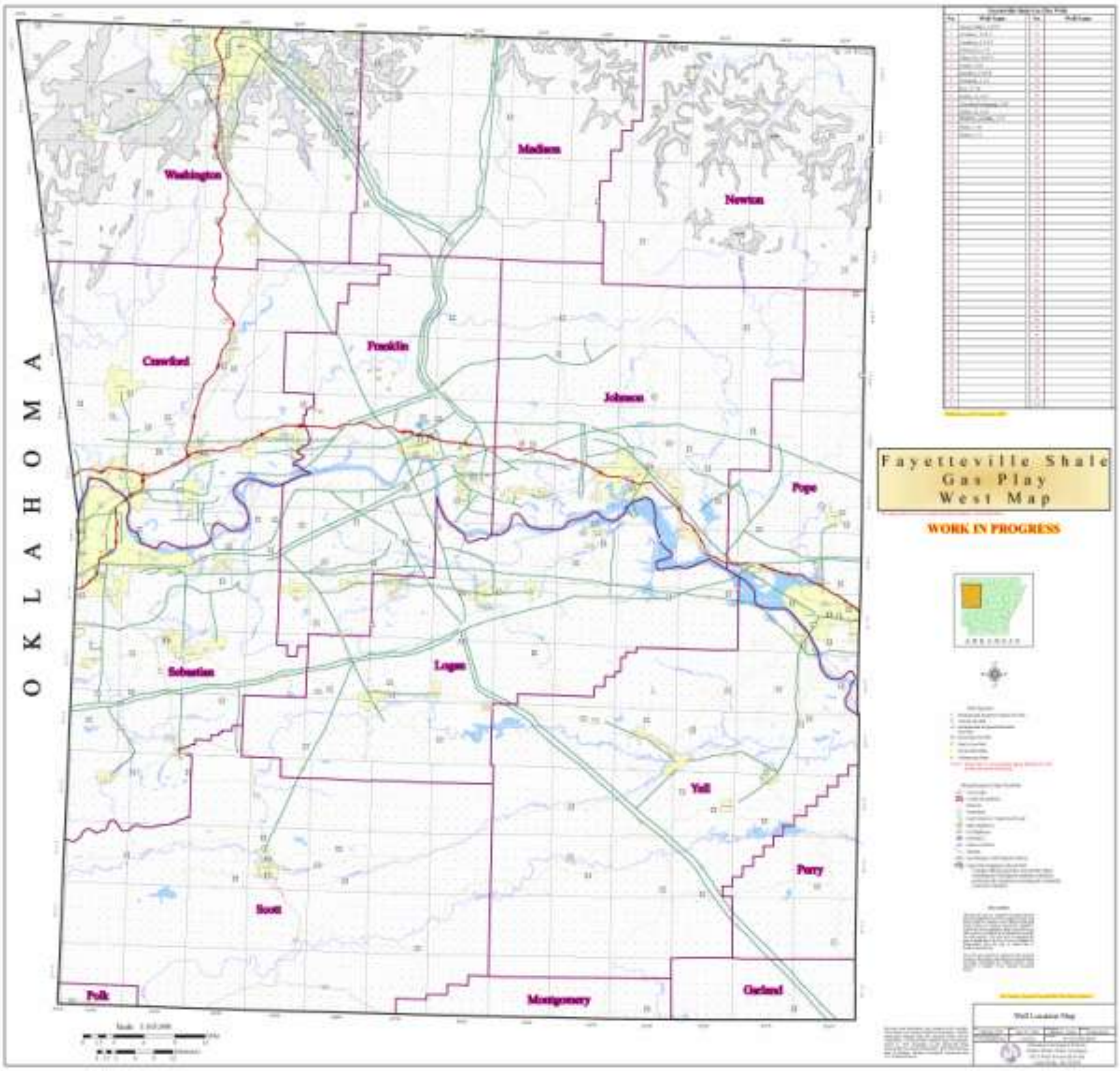


Figure 7

Arkansas Fayetteville Shale Gas Play

West Map



- Prior to final completion the Fayetteville section is stimulated with multiple staged slick-water fracture treatments. The fracture treatments generally involve 50,000 bbls of fracture water in 4 to 5 staged treatments. In some cases operators have constructed large private lakes within the area of planned drilling operations so that surface waters could be utilized during fracture treatments.
- The Fayetteville Shale produces a dry gas which is high in methane. The formation produces very little water after the initial fracture water is recovered. Produced water is handled primarily through disposal into Class II injection wells.
- Fayetteville wells can initially produce in the range of 1-3 mmcf of gas per day. However, most wells decline to 250 -300 mcf per day within two years.

Extension of the play into the Mississippian embayment area is not currently considered as a strong exploration play. The current area of Fayetteville exploration and production is in or associated with the Arkoma Basin to the east, the basin is part of an older rift basin with sediment load from the northeast and with a higher thermal gradient, much higher than the current area.

5.0 OIL AND GAS ACTIVITY IN ARKANSAS

This section deals with the current status of oil and gas activity in Arkansas based on information provided by both public and private sources. Information includes; leasing activity, well spacing requirements, drilling and completion statistics by county, Drilling practices, production statistics, oil and gas characteristics, oil and gas prices, operational costs (drilling, completion, and gathering and transmission), conflicts with other mineral development, and gas storage fields.

5.1 Leasing Activity

Leasing activity in Arkansas is on-going in three general areas that include the Fayetteville Shale play, trend development opportunities in the Arkoma Basin / Ouachita Mountain Folded Belt and the southern Arkansas Gulf Coast plain province.

The most active of these in the Arkoma Basin is the Fayetteville Shale unconventional shale-gas play which is centered in the eastern part of the basin. The Arkansas Geological Commission reports that more than 2.5 million acres of subsurface minerals have been leased within this play in a 2.5-year period (AGC, web, 2007). While leasing costs vary in this play they tend to range from $250 to $1000 per acre. The higher lease prices being related to areas with established and sustainable gas production rates (Wohlford, 2007).

Most of the other leasing activity in the general area of the Arkoma / Ouachita Mountain Folded Belt includes trend development opportunities associated with known fields or structures and a coal bed methane play which is generally located in the western portion of the basin (Bengal, 2007).

An on-going play focused on Middle and Lower Atoka reservoirs in the area of the Waveland Field situated on the Ranger anticline in Logan and Yell counties has received considerable leasing and drilling activity in recent years. It has been reported that this area will continue to be active with additional drilling contemplated by a number of operators in the area (Bengal, 2007 and Wohlford, 2007). Sizeable leasing activity, more than 50,000 acres, for potential deep gas exploration has also been noted in parts of the Ouachita Mountain Folded Belt (Montgomery County), but no information is available as to specific drilling targets.(Ratchford, 2007).

5.2 Well Spacing Requirements

Well spacing requirements for oil and gas wells drilled in Arkansas are subject to the rules and regulations of the Arkansas Oil and Gas Commission (AOGC). Spacing requirements fall under those set by specific field rules issued by the Commission upon notice and hearing and those covered under the general rules and regulations of AOGC. Summaries of existing AOGC Field Rules for both northern and southern Arkansas are attached in Appendix A.

Specific AOGC regulations which deal with spacing requirements not covered under existing field rules include Rule B-3, Rule B-40, and Rule B-43. The complete text of these rules is attached in Appendix B.

5.3 Drilling and Completion Statistics

5.3.1 Drilling Practices

For vertical drilling operations in traditional dry gas conventional reservoirs of northern and west central Arkansas the normal drilling practice is to utilize air drilling techniques (AGC, web, 2007). With the recent focus on the Fayetteville shale-gas reservoir and the apparent determination that horizontal drilling methods afford more access to the productive reservoir the drilling practice in that particular play has shifted to horizontal drilling operations and completion practices. The initial vertical segment in these wells is drilled with the traditional air drilling techniques and the horizontal lateral is drilled with an oil based drilling mud system (Bengal, 2007). Drilling operations in the Gulf Coastal Plain sub-province of southern Arkansas utilize standard mud rotary practices with fresh water mud drilling systems (AGC, web, 2007).

5.3.2 Drilling and Completion Costs

Drilling costs and well completion costs vary by depth, reservoir, and completion practice for the specific reservoir to be produced. The data in the table 5 provided below provides information relative to drilling, completion, and total well cost estimates for a cross section array of wells, depths and target reservoir. The cost estimates are from actual pre-drilling Authorizations for Expenditures (AFE) estimates prepared as part of applications filed with the Arkansas Oil and Gas Commission.

A review of the table shows total per well costs for drilling and completion for the wells reviewed ranges for from $794,883 to $3,168,000. The cost for Fayetteville shale-gas wells are generally higher because of the increased costs associated with the multiple fracture stimulation treatments performed on the wells.

5.4 Production Statistics

5.4.1 Crude Oil

Crude oil production in Arkansas averaged 652,916 bbls/month during the twelve month period from July 2006 through July, 2007(EIA, web). Monthly crude oil production data for Arkansas for the period January 2000 through July 2007 is graphically displayed with pricing information in Figure 8. As can be seen from a review of this graph the monthly crude oil production rate at the beginning of this period stood at more than 934,000 barrels of oil per month. That rate has subsequently declined to slightly more than 616,000 barrels/month as of July 2007. This production decline trend is not expected to be significantly altered as most of the oil production located in the southern part of the state is categorized as mature production that is largely dependent on infill and trend development drilling and secondary recovery operations for sustaining this rate (Bengal, 2007 and Wohlford, 2007).

DATE	COUNTY	RESERVOIR TARGET	VERTICAL / HORIZONTAL	DEPTH (TVD)	DRILLING COSTS (BCP)	COMP. COSTS (ACP)	TOTAL WELL COSTS
6/2007	Conway	Fayetteville Shale	Vertical	7025	$915,800	$1,554,500	$2,470,300
4/2007	Cleburne	Fayetteville Shale	Horizontal	7000	$1,262,480	$1,492,210	$2,754,690
6/2007	Van Buren	Fayetteville Shale	Horizontal	6600	$1,361,000	$1,402,500	$2,763,500
10/2007	White	Fayetteville Shale	Horizontal	(5626)	$1,687,000	$1,481,000	$3,168,000
8/ 2007	Faulkner	Fayetteville Shale	Horizontal	(4975)	$1,237,320	$1,762,558	$2,999,878
3/2007	Yell	Atoka Formation	Horizontal	7000	$1,108,568	$735,905	$1,819,473
3/2007	Sebastian	Turner Formation	Vertical	7800	$895,000	$413,500	$1,308,500
2/2007	Sebastian	Alma Formation	Vertical	4500	$315,000	$479,883	$794,883
10/2007	Columbia	Haynesville	Vertical	11,300	$1,149,990	$1,091,000	$2,240,990

Formation

Table 5: Drilling and Well Completion Costs

5.4.2 Natural Gas

Annual natural gas production in Arkansas for the years 2000 through 2006 is graphically displayed with pricing information in Figure 9. Unlike oil production, natural gas production has generally been on the rise since 2002 when annual production stood at 162,122 MMcf of gas for the year. Since that year annual production has risen each year through which there is data available with 2006 annual production reaching 193,942 MMcf or a 19.62% increase in production over that which was reported in 2002. This increase in production is undoubtedly because of the increase in wellhead gas prices over that period coupled with the increase in drilling operations and discoveries related to the Fayetteville Shale gas play.

5.5 Oil and Natural Gas Characteristics

5.5.1 Natural Gas

Most gas recovered from oil fields in southern Arkansas in the Gulf Coastal Plain sub-province although limited in volume is considered to be a wet gas as it contains some of the heavier fluid hydrocarbons. In contrast the gas of the Arkoma Basin in west-central and northern Arkansas is considered to be dry gas in that it does not carry appreciable amounts of the heavier hydrocarbons as vapor (AGC, web, 2007).

The dry natural gas from the fields of the Arkoma Basin has a heating value of 986 to 1,016 Btu per cubic foot with the highest CO_2 content being approximately 4% (AGC, web, 2007 and Wohlford, 2007).

5.5.2 Crude Oil

Crude oil is generally characterized by the oil's gravity and the presence or absence of any contaminates that may ultimately affect or limit the use of that crude oil in refinery operations. The standard gravity measurement is termed the API (American Petroleum Institute) gravity. API gravity is defined as: (141.5 ÷ SG) - 131.5 where SG is specific gravity at 60 degrees Fahrenheit (Schlumberger, web). Crude oils are generally termed light or heavy crudes based on the API gravity. A light crude oil is generally one with an API gravity over 40, while very heavy crude oils will typically have an API gravity of 20 or less - the higher the API gravity, the lower the density of the crude oil.

An important contaminant for crude oils in southern Arkansas, east Texas and northern Louisiana is the sulfur H_2S. When the sulfur content of a crude oil exceeds .5 % the crude is considered a “sour” crude.

Crude oil produced in the southern part of Arkansas has a wide variety of API gravity ratings. These rating vary by depth, producing reservoir, and geographic location. A review of AOGC data for oil fields located in that part of the state show API gravities ranging from a low of 11 degrees to a high of 72 degrees. In individual productive fields the API gravity for a single formation may vary as much as 34 degrees based on its position in the field (AOGC, 1995).

Recent pricing bulletins, December, 2007, for southern Arkansas and northern Louisiana require API gravity rating in the range of 34 to 44.9 degrees to receive the pricing reserved for what is termed “South Arkansas and North Louisiana Sour”. Any decrease or increase above that range results in a net reduction of $.015 / bbl in the price paid per barrel.

Figure 8: Arkansas Monthly Crude Oil Production

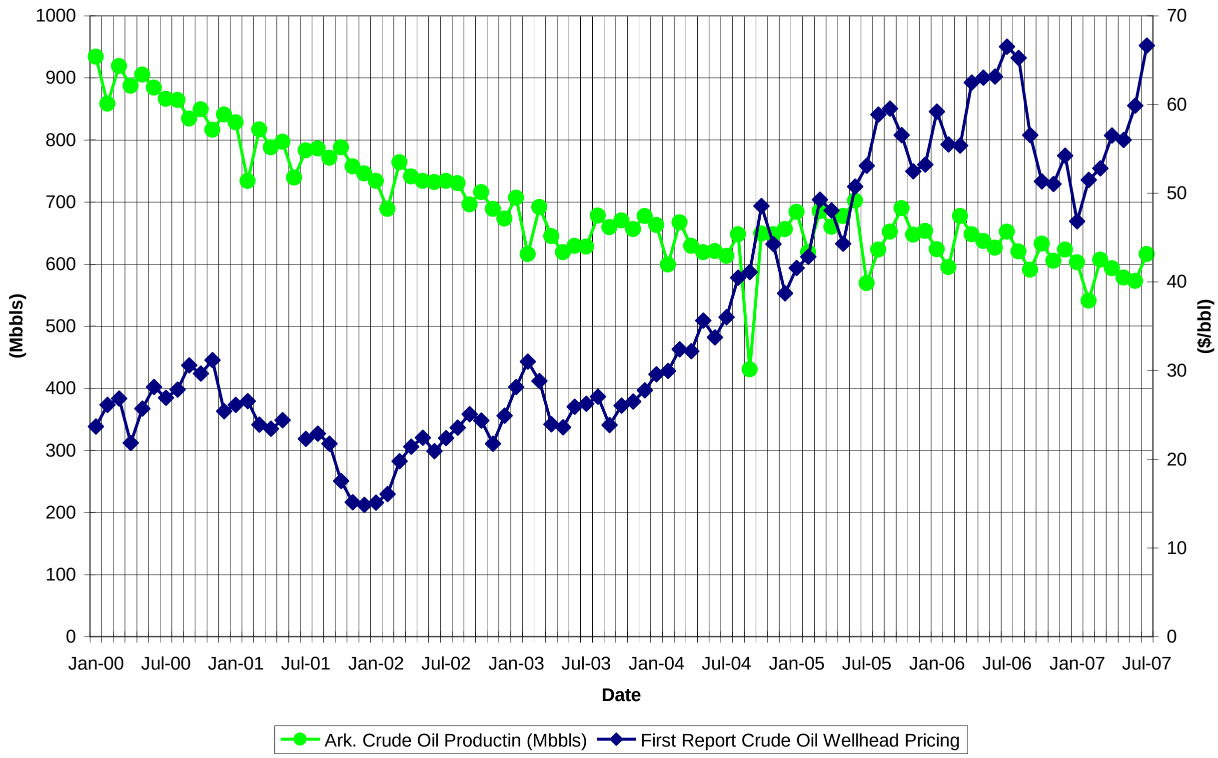
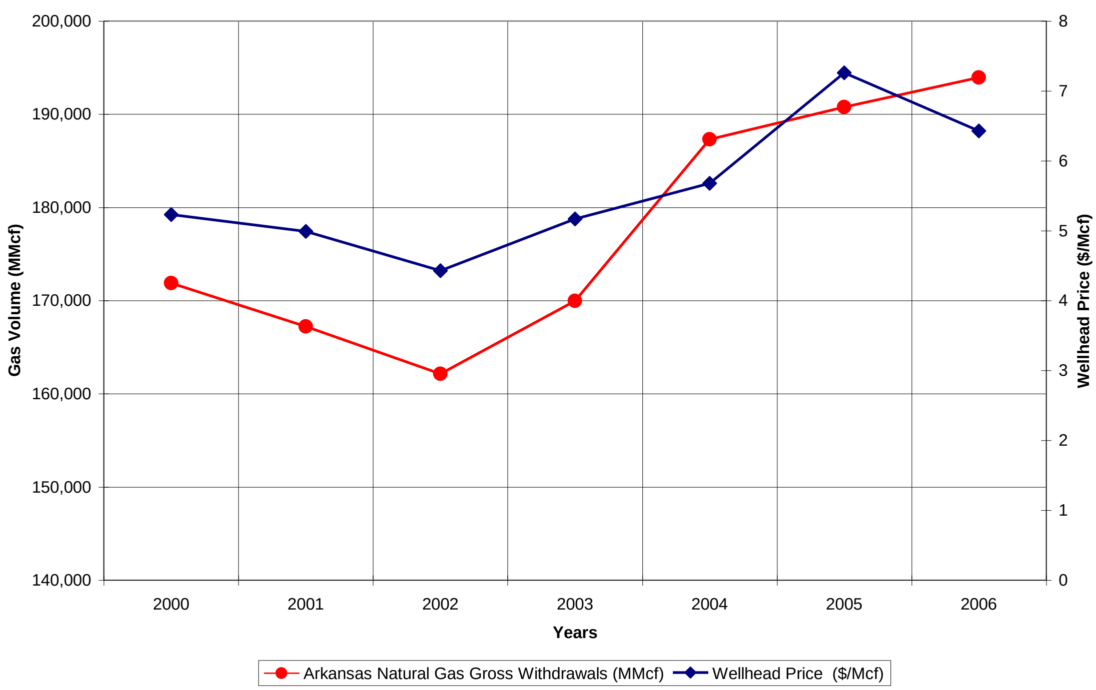


Figure 9: Arkansas Annual Natural Gas Gross Withdrawals (Production)



5.6 Oil and Gas Prices

Average monthly crude oil wellhead prices for Arkansas based data provided to EIA during the period from January 2000 through July 2007, as seen in Figure 8 show that crude oil prices have risen from 23.69 $/ bbl to 66.64 $/bbl during that timeframe. The most recent monthly average data reported to EIA show wellhead crude prices at 71.20 $/bbl for September 2007 (EIA, web).

As can be seen from a review of the graph in Figure 9 the annual average wellhead price for Arkansas natural gas reported by first purchasers has steadily risen from $5.23/Mcf in 2000 to $6.23/Mcf in 2006 (EIA, web). While annualized data for 2007 is not as of yet available, current wellhead prices are estimated to be in the order of $6.67/Mcf based on the current (12/17/2007) NYMEX posting of $7.17/Mcf.

Both crude oil and natural gas prices are generally expected to remain strong for the foreseeable future.

5.7 Conflicts with Other Mineral Development

Mineral development in Arkansas is extensive and involves in addition to oil and gas a number of different mineral resources. These include: abrasives (novaculite and Tripoli), aluminum, antimony, barite, bromine, chalk and gypsum, clay and lignite, coal, copper, dimension and decorative stone, gem stones, glass sand, iron, lead and zinc, manganese, mercury, phosphate, strontium, titanium and vanadium. Figure 10 is a map of the mineral resources of Arkansas prepared by the AGC and shows the location of these mineral deposits/mining operations of these resources to the areas of oil and natural gas resources. Based on interviews with personnel from the AGC and the AOGC there appears to be no conflicts between oil and gas operations and on-going mineral development (Bengal, 2007 and White, 2007)

5.8 Gas Storage Fields

EIA gas storage data for 2006 indicates that there are two active gas storage fields operating in the State of Arkansas (EIA website, Natural Gas Storage, Form EIA-191 Data, 2007). Both of the fields are depleted gas fields that have been converted to gas storage operations. Details with respect to the operator, field name, location, reservoir, total field capacity, and authorized maximum daily delivery for those fields are provided in Table 6.

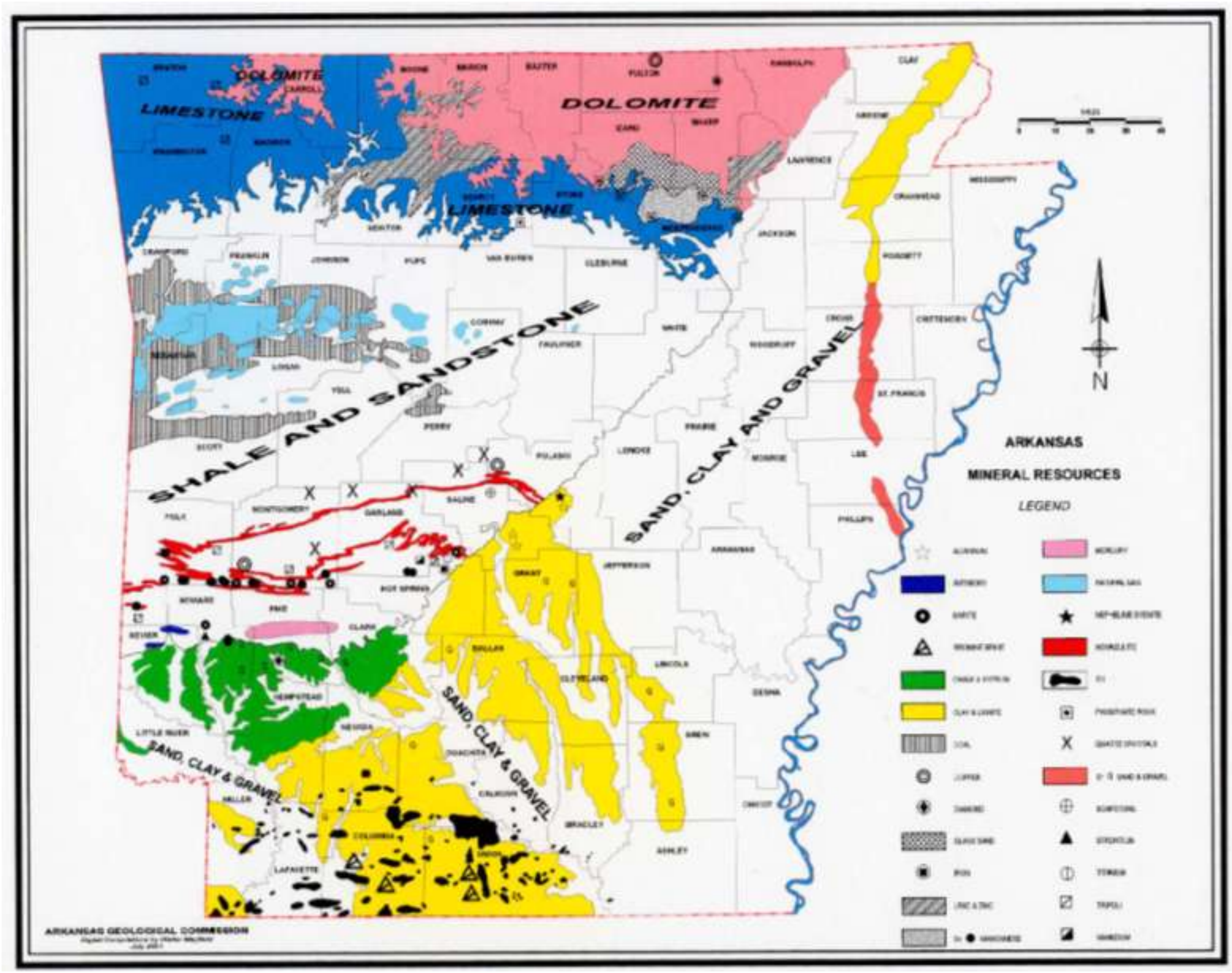
Table 6

Active Gas Storage Fields in Arkansas

Operator	Field Name	Location	Reservoir	Total Field Capacity (Mcf) (2006)	Maximum Daily Delivery (Mcf) (2006)
Arkansas Western Gas Company	Lone Elm	Franklin Co.	Henson Sand	14,500,000	70,500
Arkansas Western Gas Company	White Oak	Franklin Co.	Woolsey Sand	7,500,000	160,000

Source: (EIA website, Natural Gas Storage, Form EIA-191 Data, 2007

Figure 10: Mineral Development in Arkansas



6.0 OIL AND GAS OCCURRENCE POTENTIAL

6.1 Existing oil and gas production

Oil and gas has been produced in Arkansas for many years. Twenty-one counties have current production of natural gas while ten counties have existing oil production. Natural gas is distributed very differently from oil and the occurrence of two will be discussed separately.

6.2 Oil and Gas Exploration and Production

Various oil and natural gas plays have been exploited in Arkansas in its history. Figure 11 illustrates the state's petroleum developments in the most recent past. In the most recent years oil is still being developed with less than a hundred wells drilled per year. Conventional natural gas is being sought with several hundred wells being drilled every year, mostly in the northern part of the state. Unconventional natural gas dominates the most recent history with horizontal Fayetteville Shale wells and CBNG wells becoming most popular. CBNG production (Figure 12) has peaked in 2005 while Fayetteville Shale production (Figure 13) is still on the rise; both of these plays are in the northern portion of the state.

Figure 11: Arkansas Drilling Activity in the Past Six Years

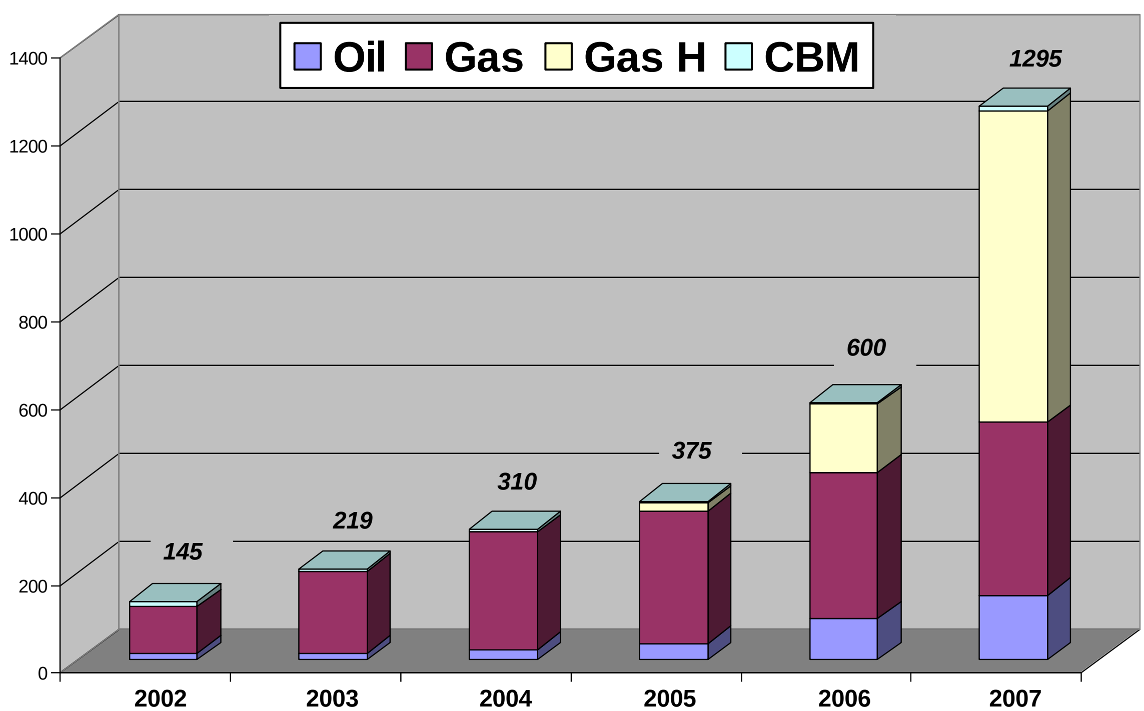


Figure 12: Annual CBNG Production (BCF)

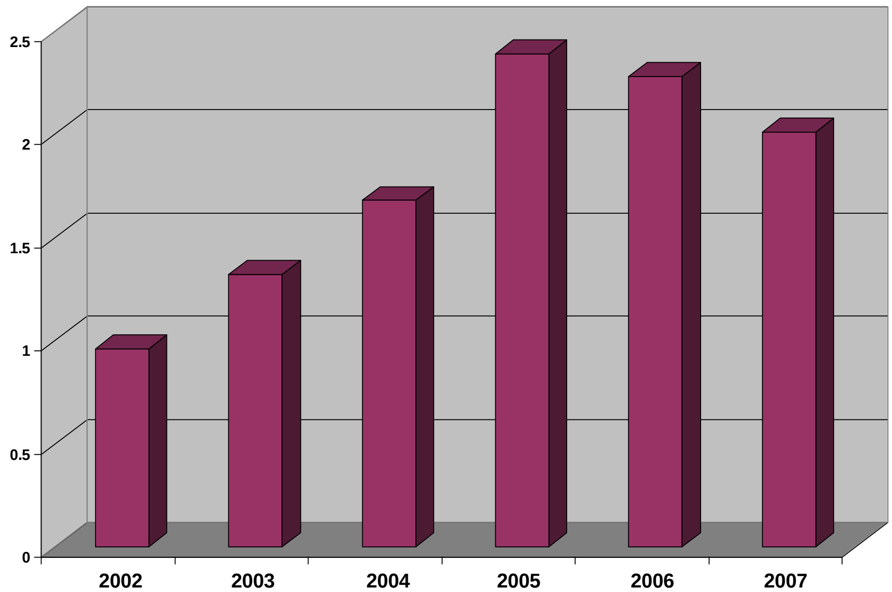
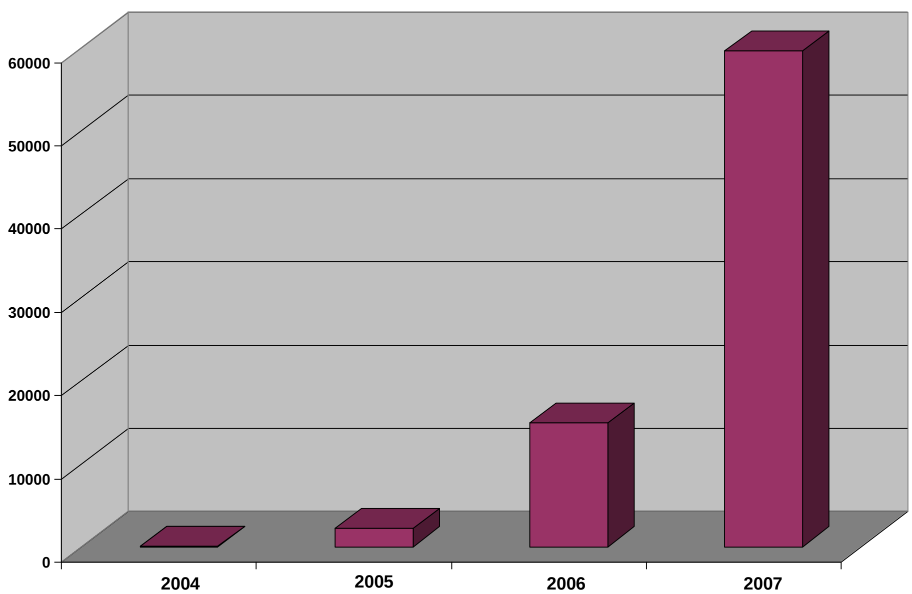


Figure 13: Annual Fayetteville Shale Production



Natural Gas: Gas is found in northern Arkansas in the Ozark uplift, Arkoma Basin, and Ouachita Fold Belt. Figure 14 plots the increase in natural gas production within the state in the past few years. The increase has been due to drilling in CBNG and Fayetteville Shale gas plays. Table 7 breaks down the natural gas production by county and ranks the counties by drilling activity and current production rate; counties not listed are ranked as very low natural gas occurrence. Figure 15 plots those counties

Figure 14: Arkansas Annual Gas Production (BCF)

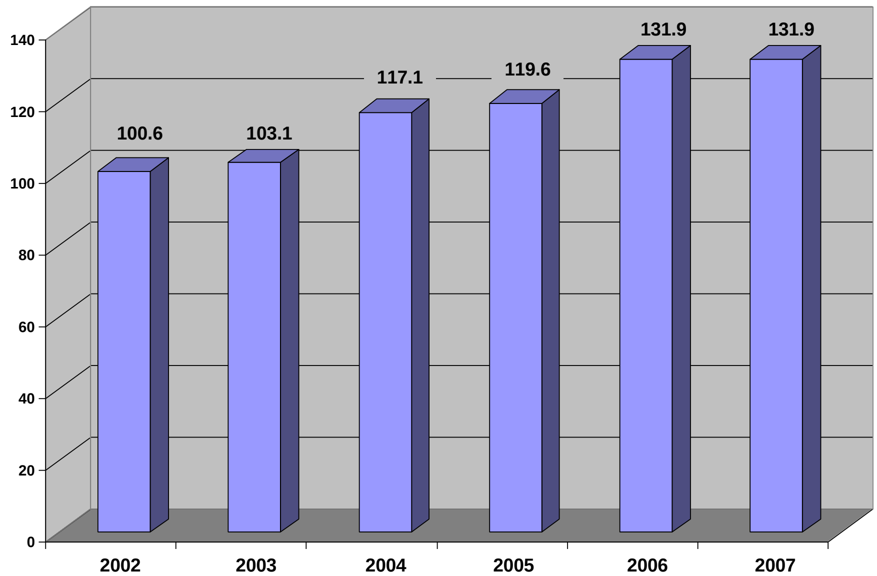
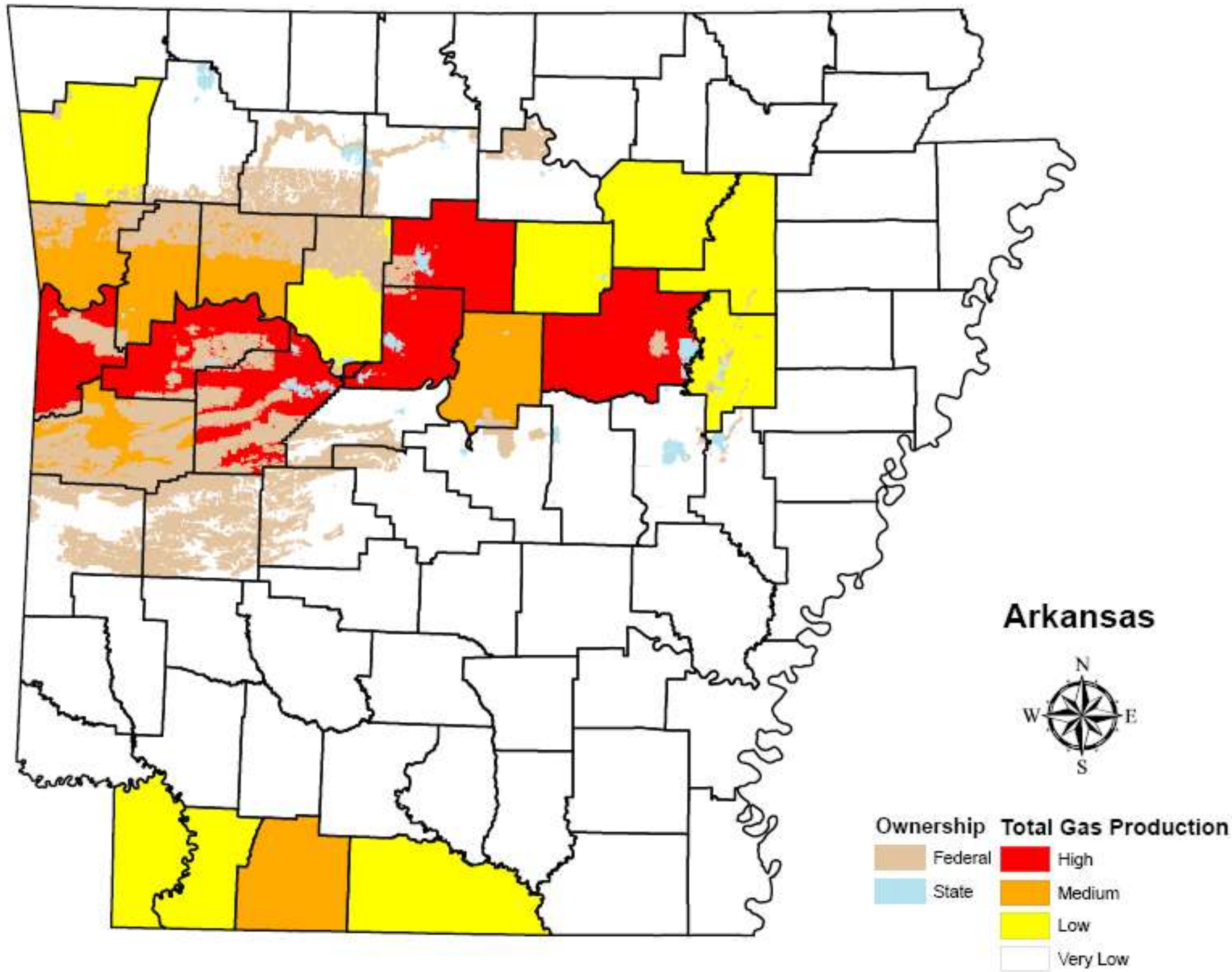


Table 7: Counties with Natural gas Production and Ranking

COUNTY	Gas Rank	2007 Gas Wells	2007 Gas Prod (BCF)
CONWAY	High	162	18.718
LOGAN	High	123	18.201
SEBASTIAN	High	85	13.967
VAN BUREN	High	196	21.26
WHITE	High	272	13.872
YELL	High	83	10.771
COLUMBIA	Medium	32	3.862
CRAWFORD	Medium	13	3.339
FAULKNER	Medium	44	6.479
FRANKLIN	Medium	17	8.611
JOHNSON	Medium	20	2.768
SCOTT	Medium	27	4.082
CLEBURNE	Low	38	1.627
INDEPENDENCE	Low	4	
JACKSON	Low	7	
LAFAYETTE	Low	0	1.4
MILLER	Low	0	0.984
POPE	Low	26	1.819
UNION	Low	0	0.094
WASHINGTON	Low	3	0.011
WOODRUFF	Low	3	

Figure 15: Ranking of Natural Gas Occurrence in Arkansas



that are ranked high, medium, low, and very low in spatial relationship to Federal minerals; counties ranked as very low are not colored.

Crude Oil: Oil is produced only in the Gulf Coastal Plain in southern Arkansas. Figure 16 illustrates the on-going decline in production that has continued for a number of years. Table 8 breaks down the crude oil production by county and ranks the counties considering drilling activity and production rate. counties not listed are ranked as very low crude oil occurrence. Figure 17 plots those counties that are ranked high, medium, low, and very low in spatial relationship to Federal minerals; counties ranked as very low are not colored.

Figure 16: Annual Arkansas Oil production (Bbls)

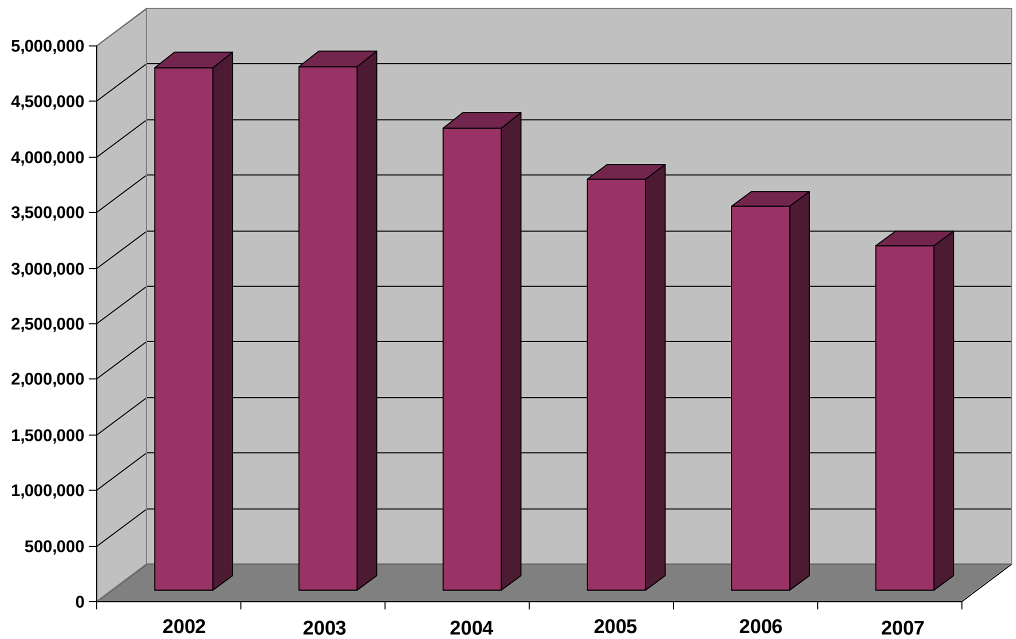
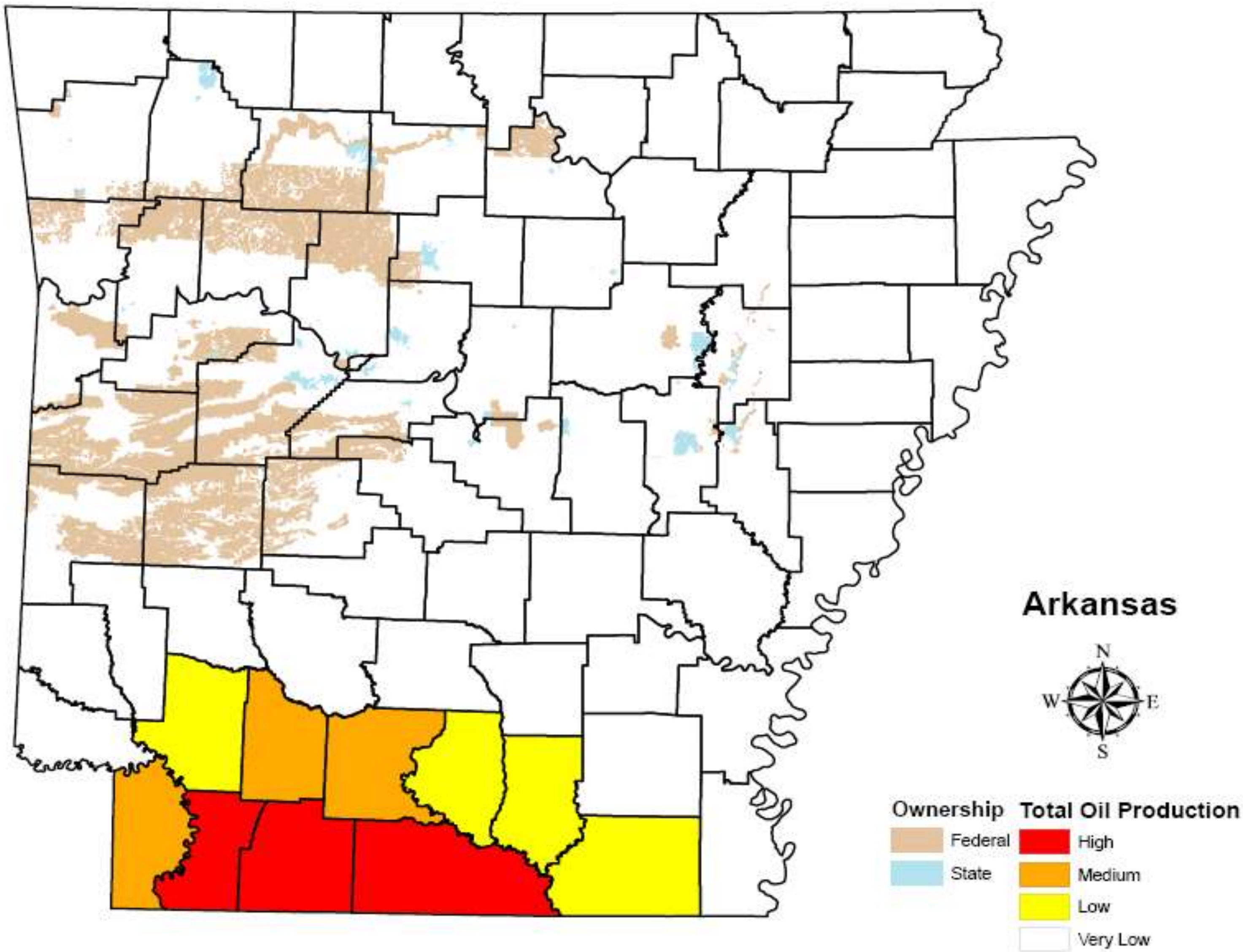


Table 8: Counties with Crude Oil Production and Ranking

COUNTY	Oil Rank	2007 Oil Wells	2007 Oil Prod
COLUMBIA	High	32	1,141,445
UNION	High	64	496,730
LAFAYETTE	High	15	498,925
MILLER	Medium	3	257,547
NEVADA	Medium	18	129,191
OUACHITA	Medium	33	536,144
ASHLEY	Low	0	3,005
BRADLEY	Low	0	8,047
CALHOUN	Low	0	19,819
HEMPSTEAD	Low	0	2,868

Figure 17: Ranking of Crude Oil Occurrence in Arkansas



7.0 Oil and Gas Development Potential

7.1 Relative Oil and Gas Development Potential

Counties are ranked in the previous section according to current production and drilling activity. Many of these counties have seen increased oil and gas activity since approximately 2002, driven by increases in crude oil price. It is expected that the current historical high price for oil (between $90 and $100 per bbl) will continue into the future or increase to some extent. If, on the other hand, crude oil prices were to slip downward, drilling rates would likely be reduced.

The six counties ranked High for natural gas (Figure 18) have showed a marked increase in drilling in the past six years in response to higher commodity prices. This is especially true for the three counties singled out in the plot labeled Figure 19; all three counties are centers of intense Fayetteville Shale development. It is expected that the counties labeled as high-rank will show continued increases in development and in drilling.

Medium rank (Figure 20) and low rank (Figure 21) counties have shown little growth in drilling, in spite of increased oil and gas prices in the past few years. It is expected that these counties will see a small number of wells drilled each year but show little or no increase in the rate of drilling.

Figure 18: High Rank Gas Development

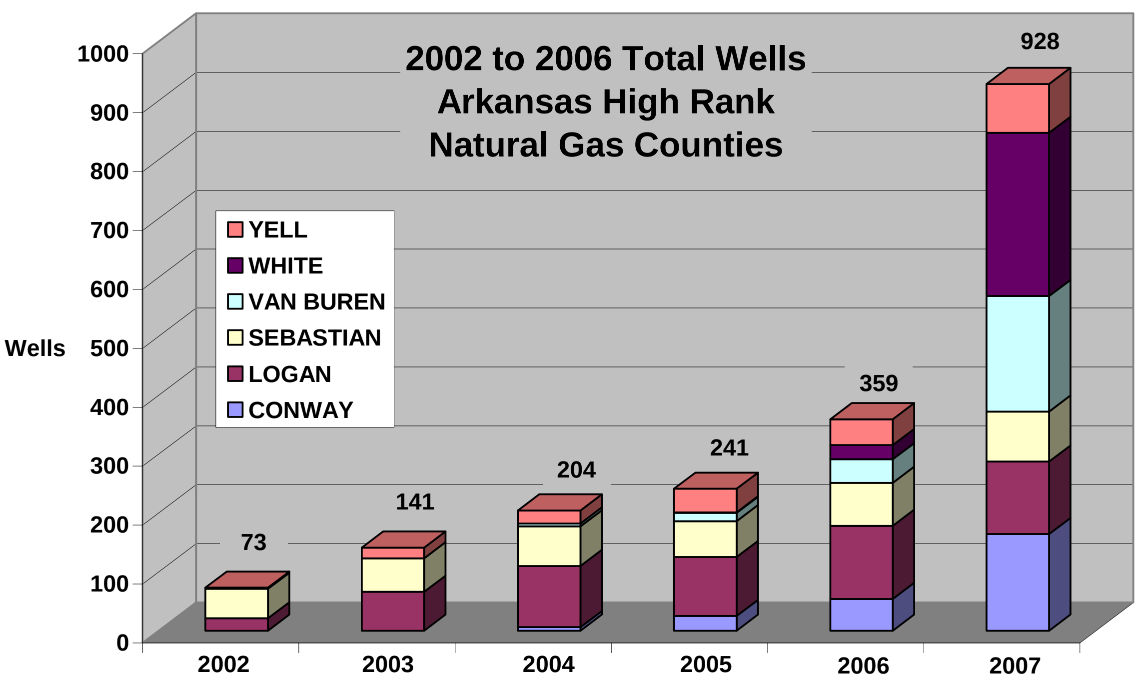


Figure 19: Super-High rank gas Development

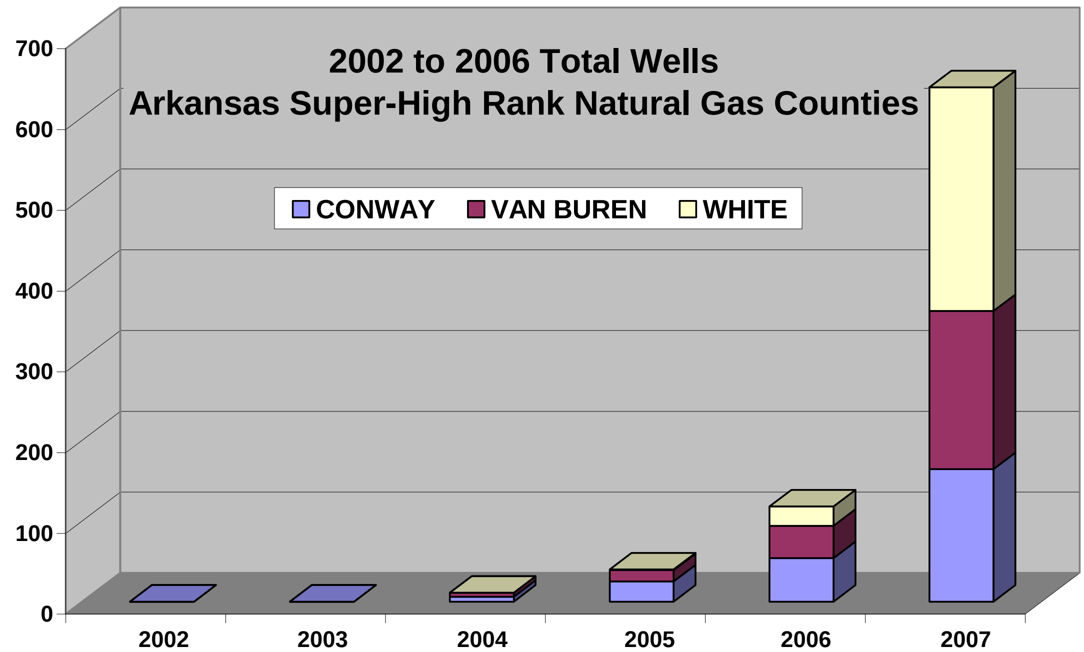


Figure 20: Medium Rank Gas Development

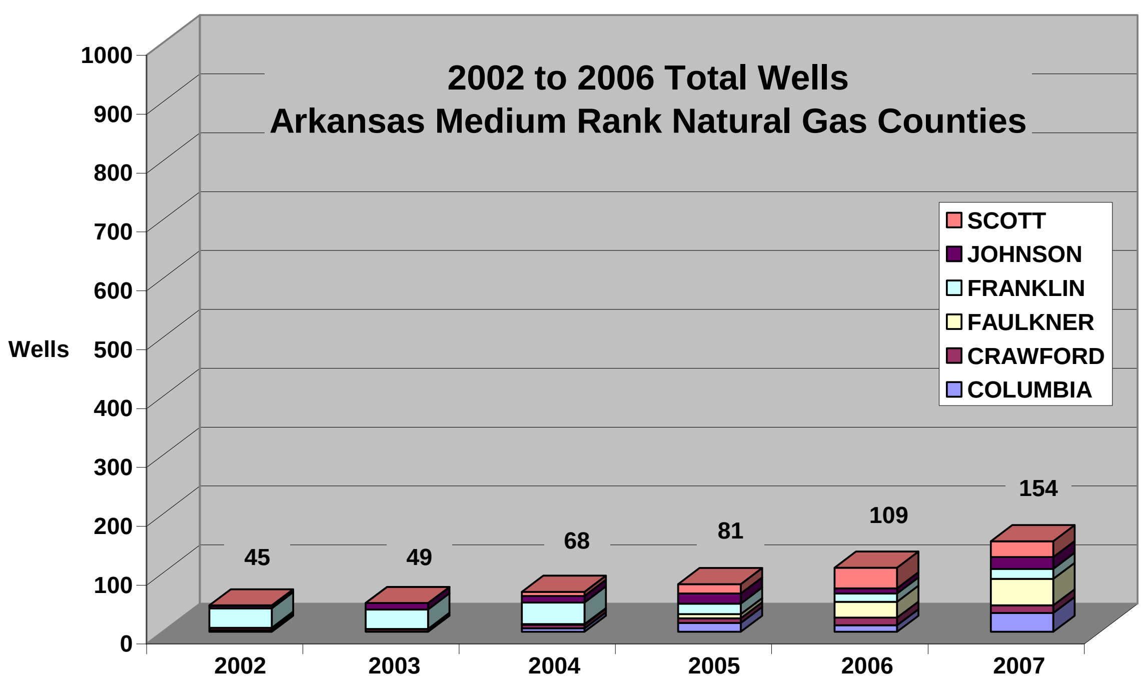
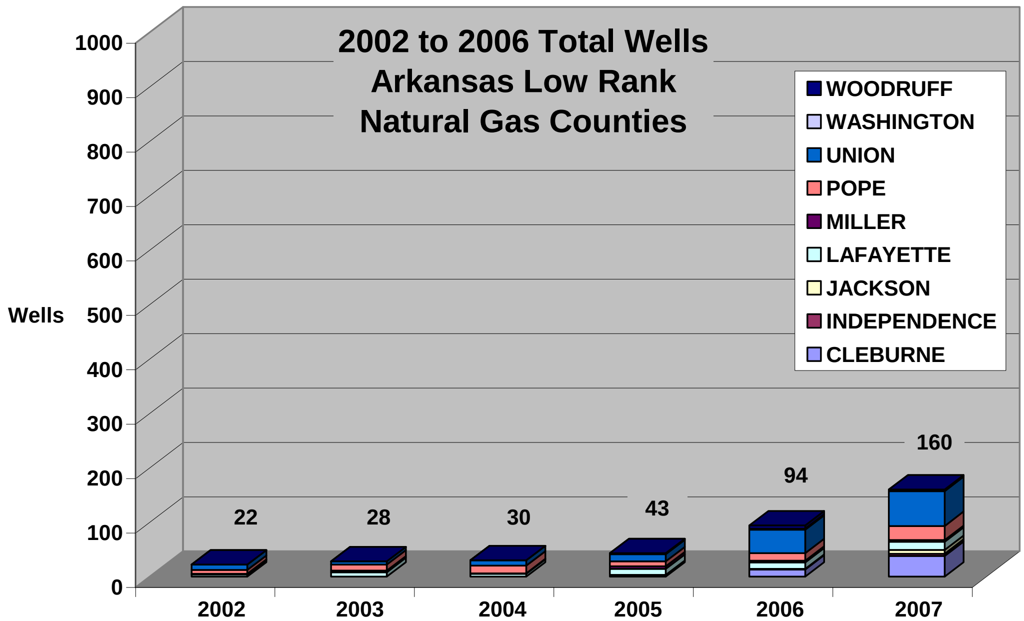


Figure 21: Low Rank Gas Development



7.2 Drilling Development

Drilling rate increases are best seen in those counties rated as high rank, typified by White County. This county has seen total new wells climb from zero in 2002, 2003, and 2004, one in 2005, 24 in 2006, and 272 in 2007. All of this drilling was for Fayetteville Shale; most of this drilling involved horizontal legs and no holes were dry. Production during this period was similar; most of the production was from the Fayetteville. In 2007 Fayetteville production totaled 12.17 BCF with approximately 1.6 BCF produced from the Arbuckle, Hale, Brentwood, and Moorefield. If we assume that drilling during the next ten years will be for Fayetteville Shale, we can predict that the limit will be two wells per 320 acres across the county; we can also assume that 90% of these will be horizontal wells. White County has a total of 666,987 acres and 4,169 Fayetteville Shale wells could be fitted into the county. If 297 wells have already been drilled, this leaves 3,872 wells to be drilled or 388 per year. Approximately 2% of White county is federal acreage therefore approximately eight Fayetteville Shale wells are expected to be drilled on federal acreage every year.

Tables 9 and 10 list all the ranked natural gas and crude oil with forecast total wells to be drilled and federal wells forecast to be drilled on a yearly basis. The expected annual total of 157 natural gas wells and zero oil wells will result in a measurable amount of surface impact on federal lands. The gas wells to be drilled will be 90% horizontals and require large pads during the drilling and smaller areas during the producing lives of the wells. Note a trend towards drilling multiple horizontal wells from one pad has been observed in the Fayetteville and Atoka fields. The remaining gas wells will require large drill-rigs and moderately large drilling-pads and smaller producing leases after completion. No dry holes are expected.

Table 9: Ten-Year Forecast of Gas Wells in Arkansas

COUNTY	Gas Rank	Federal acres	Total Acres	2007 Wells	2002-2007 wells	Forecast Annual Gas Wells[1]	Forecast Annual Federal Gas Wells (Horizontal)		% Fed Acreage
							BLM	USFS	
CONWAY	High	7,324	362,660	162	247	89 (80)	0	2 (2)	2.02%
LOGAN	High	105,587	468,116	123	532	93 (84)	2 (1)	19 (18)	22.56%
JOHNSON	High	173,401	436,912	20	72	150 (135)	0	59 (53)	39.69%
POPE	High	188,189	531,629	26	72	150 (135)	0[2]	53 (48)	35.40%
SEBASTIAN[3]	High	79,024	349,551	85	413	68 (49)	2 (2)[4]	3 (2)	22.61%
VAN BUREN	High	31,615	463,483	196	255	119 (105)	0	8 (8)	6.82%
WHITE	High	13,166	666,987	272	297	179 (155)	4 (4)[2]	0	1.97%
YELL	High	231,216	607,252	83	210	169 (150)	2 (2)[5]	2 (2)[5]	38.08%
CLEBURNE	Medium	0	378,774	38	54	38 (34)	0	0	0.00%
COLUMBIA	Medium	0	491,451	32	68	0	0	0	0.00%
CRAWFORD	Medium	87,346	386,598	13	47	13 (12)	0	3 (3)	22.59%
FAULKNER	Medium	12,748	425,004	44	79	44 (40)	1 (1)	0	3.00%
FRANKLIN	medium	111,666	396,527	17	147	17 (15)	0	5 (5)	28.16%
INDEPENDENCE	Low	0	493,751	4	4	4 (4)	0	0	0.00%
JACKSON	Low	2,128	410,476	7	8	7 (6)	0[2]	0	0.52%
LAFAYETTE	Low	0	349,519	15	55	0	0	0	0.00%
MILLER	Low	0	408,431	3	15	0	0	0	0.00%
SCOTT	Low	361,360	574,824	27	86	27 (24)	0	17 (15)	62.86%
UNION	Low	0	676,452	64	146	0	0	0	0.00%
WASHINGTON	Low	21,980	611,854	3	7	3 (3)	0	0	3.59%
WOODRUFF	Low	10,654	380,168	3	9	3 (3)	0	0	2.80%
Total						**1,173 (1,034)**	**11 (10)**	**171 (156)**	

1 - Forecasted annual gas wells represent all mineral owners, state, fee, and federal.
2 – Indicates the federal mineral estate is beneath a US Fish and Wildlife Refuge therefore it is optimistic to forecast wells.
3 – There will be CBNG wells drilled in Sebastian County (14 per year) of which a portion will be horizontally drilled (7 per year).
4 – Gas potential is high but considerable federal acreage in the county is on Ft. Chaffee and inaccessible due to DoD opposition.
5 – Federal acreage in Yell County appears to have low potential at the present time.

Table 10: Ten-Year Forecast of Oil Wells in Arkansas

COUNTY	Oil Rank	Federal acres	Total Acres	2007 Wells	2002-2007 wells	% Fed Acreage	Forecast Annual Oil Wells	Forecast Annual Fed Oil Wells
UNION	High	0	676,452	64	146	0.00%	64	0
COLUMBIA	High	0	491,451	32	68	0.00%	32	0
ASHLEY	Low	0	601,947	0	0	0.00%	0	0
BRADLEY	Low	0	419,308	0	1	0.00%	0	0
CALHOUN	Low	0	405,278	0	0	0.00%	0	0
HEMPSTEAD	Low	0	474,904	0	1	0.00%	0	0
LAFAYETTE	Medium	0	349,519	15	55	0.00%	15	0
MILLER	Medium	0	408,431	3	15	0.00%	3	0
NEVADA	Medium	0	397,689	18	31	0.00%	18	0
OUACHITA	Medium	0	473,878	33	71	0.00%	33	0
Total							**165**	**0**

8.0 REASONABLE FORESEEABLE DEVELOPMENT BASELINE SCENARIO ASSUMPTIONS AND DISCUSSION

This RFD scenario assumes that all potentially productive areas are open under the standard lease terms and conditions except those areas designated as closed to leasing by law, regulation, or executive order. The areas closed to leasing typically include Areas of Critical Environmental Concern (ACECs), Wilderness Study Areas (WSAs) and USFWS Wildlife Refuges. Within the State of Arkansas there are 5 USFWS refuges and no ACECs or WSAs that occur within the counties that have federal development potential. The RFD scenario contains projections for the number or wells and acres disturbed for these counties. This in no way is intended to imply that the BLM are making decisions about the Forest Service lands or the USFWS lands. The predictions are intended to provide the information necessary so that all potential cumulative impacts can be analyzed. The disturbance for each well is based on the typical depth of wells for an area; generally, shallow gas wells disturb fewer acres than deeper oil wells. The assumptions for conventional oil and gas are as follows:

The number of wells was calculated based on historical statistics and data trends as follows:

- Wells drilled to date were taken from the Arkansas Oil and Gas Commission's public database.
- The number of wells drilled to date was statistically analyzed to calculate a median per year wells drilled per county.
- The data trends associated with the last 7 years (2000-2006) represents a more accurate estimate of future development trends than historical data, thus, it is weighted more heavily.
- The data trends from 1992 to present data set are a more accurate estimate of future trends than the complete historical record and were weighted more heavily than the historical record.
- The data trends for the complete historical record represent the least acturate estimate of future development trends and, thus, it was weighted the lightest.
- For each geographic/geologic boundary region and sub region, the calculated estimates for future development were summed to obtain a per year well count.
- Wellhead oil and gas prices are a driving force for well drilling and completion; current prices are historically high and have resulted in increased activity throughout the state. An estimate of activity for the future well development to into consideration this influence. The forecast assumes wellhead oil and gas prices will remain high and development over the next 10 years will continue at an elevated rate.
- Estimates of well counts for the different mineral ownership entities are based on spatial analysis of the percent of mineral ownership within each county times the total number of producing wells anticipated to be developed in that boundary area.
- The average acreage figure (acres per well) for the resource area was used to estimate federal disturbed acres.
- The RFD projections have a 10-year life.
- The number of dry holes was determined based on historic analysis of dry holes in the geologic boundary areas.

The assumptions were used to calculate the number of wells to be drilled, the number of in-field compressors, and the number of sales compressors required.

9.0 SURFACE DISTURBANCE DUE TO OIL AND GAS ACTIVITY ON ALL LANDS

9.1 Surface Disturbances

Estimates of the surface disturbances associated with the development of oil and gas on federal minerals within the State of Arkansas were determined from a variety of resources, including previous oil and gas environmental assessments, discussions with BLM and state oil and gas personnel, discussions with various operators, and document review.

The level of disturbance associated with conventional oil and gas development varies depending on the depth of the well and type of well drilled (horizontal vs. vertical). A shallow oil and gas well (<2,000 feet deep) typically includes a well pad of 2.0 acres, 0.10 miles of gravel road and 0.55 miles of utility lines for a total construction disturbance area of approximately 4.8 acres. Deeper oil and gas wells (5,000 to 12,000 feet below surface) require a greater disturbance area to accommodate the larger amount of equipment necessary to complete drilling. Usually a 3.25 acre well pad, 0.075 miles of gravel road, and 0.475 miles of utility lines for a total of 6.7 disturbed acres during the construction phase. Horizontal wells are typically drilled using a larger well pad estimated at 3.5 acres. However, the total construction disturbance for a horizontal oil and gas well is estimated to be 6.9 acres. Multi-wells pads are often used for development with horizontal wells to minimize the “environmental footprint”. Using the 2 wells per 320 acre assumption, a total of four wells can be drilled from one site with slightly increased surface disturbance but significantly less surface disturbance on a per well basis as shown in Table 14. In this instance a 6.2 acre pad is used along for a total construction disturbance of 11.52 acres (as the other disturbances remain the same) but this reduces the per-well disturbance to 2.87 acres per well during construction. An example of this is shown in Figure 22. This estimate is greater than the disturbance from deep oil and gas wells because the surface disturbance required for construction of both utility and transportation lines will be somewhat more for horizontal wells. Tables 11, 12, 13, and 14 present surface disturbance estimates for conventional shallow and deep oil and gas wells and horizontal wells along with their associated support facilities. The data for surface disturbances from CBNG wells are presented in Table 15 below.

The surface disturbances are scaled to a per well disturbance level so that calculation of the total disturbance can be generated at the project, field, or county level by multiplying the number of wells for analysis by the numbers provided in the table. Existing surface disturbances are commensurate with the estimates provided in Table 11, 12, 13, 14, and 15.

9.2 Site Construction

The shortest feasible route is chosen to minimize haulage distances and construction costs while considering environmental factors and the surface owner’s wishes. The access roads are typically constructed using bulldozers and graders to connect the existing road or trail and the drillsite. In some cases improvements such as cattle guards and culvert crossings are installed because of the terrain.

In the planning area the kind of drill rig and drilling depth varies and is determined by the geologic province and expected product from the well. The extent of surface disturbance necessary for construction depends on the terrain, depth of the well, drill rig size, circulating system, and safety standards. The depth of the drill test determines the size of the work area necessary, the need for all-weather roads, water requirements, and other needs. The terrain influences the construction problems and the amount of surface area to be disturbed. Reserve pit size may vary because of well depth, drill rig size, or circulating system.

Access roads to well sites usually consist of running surfaces 14 to 18 feet wide that are ditched on one or both sides. Many of the roads constructed will follow existing roads or trails. New roads might be necessary because existing roads are not at an acceptable standard. For example, a road may be too steep so that realignment is necessary.

Figure 22: Schematic for Drilling Two Horizontal Wells per 320-Acre Spacing Unit from a Four-Well Pad

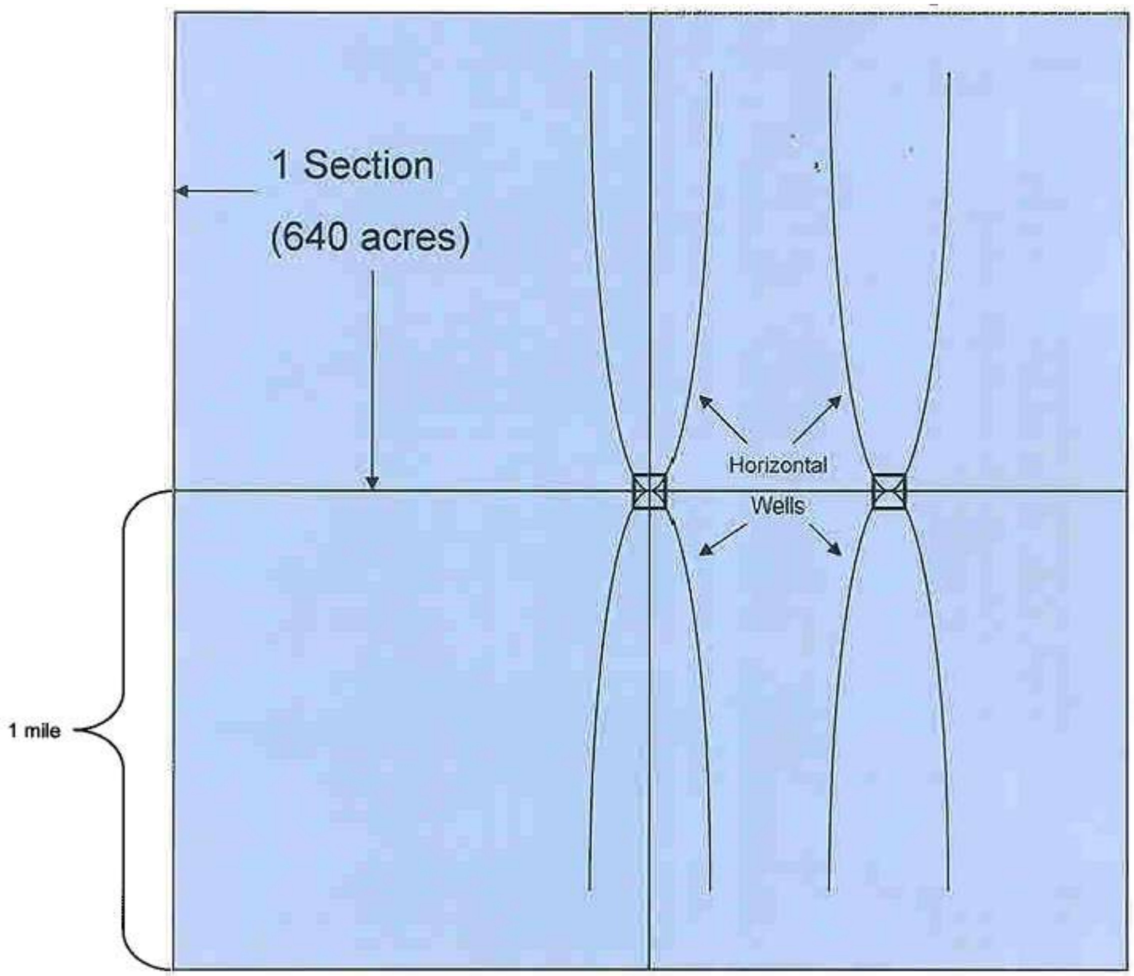


TABLE 11
LEVEL OF DISTURBANCE FOR CONVENTIONAL SHALLOW OIL AND GAS WELLS AND ASSOCIATED PRODUCTION FACILITIES

FACILITIES		Exploratory Well Disturbance (acres/well)	Construction Disturbance (acres/well)	Operation/ Production Disturbance (acres/well)
Well Pad (300-foot by 300-foot pad during drilling and construction, 175-foot by 175-foot pad during operation)		2.07	2.07	0.70
Access Roads to Well Sites	Two-track (12-foot wide by 0.25 miles long)	0.36	N/A	N/A
	Graveled (20-foot wide by 0.10 miles long for construction and operation)	N/A	N/A	0.24
	Bladed (20-foot wide by 0.10 miles for construction and operation)	N/A	0.24	0.0
Utility Lines[1]	Water lines (15-foot by 0.20 miles)	N/A	0.18	0.0
	Overhead Elec. (10-foot by 0.15 miles)	N/A	0.12	0.03
	Underground Elec. (15-foot by 0.20 miles)	N/A	0.36	0.0
Transportation Lines[2]	Intermediate Press. Gas line to and from field compressor (15-foot by 0.1 miles)	N/A	0.18	0.045
	High Press. Gas or Crude Oil Gathering Line (20-foot by 0.25 miles)	NA	0.61	0.15
Processing Areas	Tank Battery (one 0.50-ac tank battery per 20 wells)	N/A	0.025	0.025
	Access Roads (25-foot by 0.05 miles)	N/A	0.15	0.15
	Field Compressor (0.5-acre pad per 20 wells)	N/A	0.025	0.025
	Sales Compressor (2-ac pad for 150 wells)	N/A	0.01	0.01
	Sales Line (20-foot by 5 miles per 200 wells)	N/A	0.061	0.015
Produced Water Management	Produced Water pipeline (15-foot by 0.25 miles)	N/A	0.45	0.11
	Water plant/ Inj well (6 ac site per 20 wells)	N/A	0.3	0.3
Total Disturbance per Conventional Shallow Oil or Gas Well (acres)		**2.43**	**4.79**	**1.81**

1. The operation disturbance for utilities assumes all utilities will be completed underground, and the land surface will be reclaimed so that no disturbance should remain except where noted.
2. It is assumed that each conventional oil and gas well will need product pipeline and produced water line from the well. In addition, some wells will need intermediate pipeline run from the field compressor to sales line.

TABLE 12
LEVEL OF DISTURBANCE FOR CONVENTIONAL DEEP OIL AND GAS WELLS AND ASSOCIATED PRODUCTION FACILITIES

FACILITIES		Exploratory Well Disturbance (acres/well)	Construction Disturbance (acres/well)	Operation/ Production Disturbance (acres/well)
Well Pad (375-foot by 375-foot pad during drilling and construction, 200-foot by 200-foot pad during operation)		3.23	3.23	0.92
Access Roads to Well Sites	Two-track (12-foot wide by 0.5 miles long)	0.73	N/A	N/A
	Graveled (20-foot wide by 0.075 miles long for construction and operation)	N/A	N/A	0.18
	Bladed (20-foot wide by 0.075 miles for construction and operation)	N/A	0.18	N/A
Utility Lines[1]	Water lines (12-foot by 0.20 miles)	N/A	0.29	0.0
	Overhead Elec. (10-foot by 0.075 miles)	N/A	0.09	0.023
	Underground Elec. (15-foot by 0.20 miles)	N/A	0.36	0.0
Transportation Lines[2]	Intermediate Press. Gas line to and from field compressor (15-foot by 0.075 miles)	N/A	0.14	0.034
	High Press. Gas or Crude Oil Gathering Line (25-foot by 0.5 miles)	NA	1.21	0.30
Processing Areas	Tank Battery (one 0.50-ac tank battery per 15 wells)	N/A	0.03	0.03
	Access Roads (25-foot by 0.05 miles)	N/A	0.15	0.15
	Field Compressor (0.5-acre pad per 15 wells)	N/A	0.03	0.03
	Sales Compressor (2-ac pad for 150 wells)	N/A	0.01	0.01
	Sales Line (25-foot by 6 miles per 150 wells)	N/A	0.12	0.12
Produced Water Management	Produced Water pipeline (15-foot by 0.25 miles)	N/A	0.45	0.11
	Water plant/ Inj well (6 ac site per 15 wells)	N/A	0.40	0.40
Total Disturbance per Conventional Deep Oil or Gas Well (acres)		**3.96**	**6.71**	**2.24**

1. The operation disturbance for utilities assumes all utilities will be completed underground, and the land surface will be reclaimed so that no disturbance should remain except where noted.
2. It is assumed that each conventional oil and gas well will need product pipeline and produced water line from the well. In addition, some wells will need intermediate pipeline run from the field compressor to sales line.

TABLE 13
LEVEL OF DISTURBANCE FOR HORIZONTAL GAS WELLS AND ASSOCIATED PRODUCTION FACILITIES

FACILITIES		Exploratory Well Disturbance (acres/well)	Construction Disturbance (acres/well)	Operation/ Production Disturbance (acres/well)
Well Pad (360-foot by 360-foot pad during drilling and construction, 200-foot by 200-foot pad during operation)		2.98	2.98	0.92
Access Roads to Well Sites	Two-track (15-foot wide by 0.25 miles long)	0.45	N/A	N/A
	Graveled (15-foot wide by 0.15 miles long for construction and operation)	N/A	0.0	0.27
	Bladed (15-foot wide by 0.15 miles for construction and operation)	N/A	0.27	0.0
Utility Lines[1]	Water lines (15-foot by 0.5 miles)	N/A	0.90	0.0
	Overhead Elec. (10-foot by 0.15 miles)	N/A	0.18	0.045
	Underground Elec. (15-foot by 0.15 miles)	N/A	0.27	0.0
Transportation Lines[2]	Intermediate Press. Gas line to and from field compressor (15-foot by 0.25 miles)	N/A	0.45	0.11
	High Press. Gas or Crude Oil Gathering Line (20-foot by 0.5 miles)	NA	1.21	0.30
Processing Areas	Tank Battery (one 0.50-ac tank battery per 16 wells)	N/A	0.031	0.031
	Access Roads (25-foot by 0.05 miles)	N/A	0.15	0.15
	Field Compressor (0.5-acre pad per 16 wells)	N/A	0.031	0.031
	Sales Compressor (2-ac pad for 128 wells)	N/A	0.016	0.016
	Sales Line (20-foot by 4 miles per 128 wells)	N/A	0.075	0.019
Produced Water Management	Discharge Point	N/A	N/A	N/A
	Storage Impoundment (20 acres each serving 64 wells)	N/A	0.31	0.31
Total Disturbance per Horizontal Oil or Gas Well (acres)		**3.43**	**6.90**	**2.21**

1. The operation disturbance for utilities assumes all utilities will be completed underground, and the land surface will be reclaimed so that no disturbance should remain except where noted.
2. It is assumed that each conventional oil and gas well will need product pipeline and produced water line from the well. In addition, some wells will need intermediate pipeline run from the field compressor to sales line.

TABLE 14
LEVEL OF DISTURBANCE FOR HORIZONTAL GAS WELLS AND ASSOCIATED PRODUCTION FACILITIES (4 WELLS PER PAD)

FACILITIES		Exploratory Well Disturbance (acres/pad)	Construction Disturbance (acres/pad)	Operation/ Production Disturbance (acres/pad)
Well Pad (540-foot by 500-foot pad during drilling and construction, 200-foot by 200-foot pad during operation)		6.20	6.20	0.92
Access Roads to Well Sites	Two-track (15-foot wide by 0.25 miles long)	0.45	N/A	N/A
	Graveled (15-foot wide by 0.15 miles long for construction and operation)	N/A	0.0	0.27
	Bladed (15-foot wide by 0.15 miles for construction and operation)	N/A	0.27	0.0
Utility Lines[1]	Water lines (15-foot by 0.5 miles)	N/A	0.90	0.0
	Overhead Elec. (10-foot by 0.15 miles)	N/A	0.18	0.045
	Underground Elec. (15-foot by 0.15 miles)	N/A	0.27	0.0
Transportation Lines[2]	Intermediate Press. Gas line to and from field compressor (15-foot by 0.25 miles)	N/A	0.45	0.11
	High Press. Gas or Crude Oil Gathering Line (20-foot by 0.5 miles)	NA	1.21	0.30
Processing Areas	Tank Battery (one 0.50-ac tank battery per 16 wells)	N/A	0.125	0.125
	Access Roads (25-foot by 0.05 miles)	N/A	0.15	0.15
	Field Compressor (0.5-acre pad per 16 wells)	N/A	0.125	0.125
	Sales Compressor (2-ac pad for 128 wells)	N/A	0.063	0.063
	Sales Line (20-foot by 4 miles per 128 wells)	N/A	0.30	0.076
Produced Water Management	Discharge Point	N/A	N/A	N/A
	Storage Impoundment (20 acres each serving 64 wells)	N/A	1.25	1.25
Total Disturbance per Horizontal Oil or Gas Well (Total acres divided by 4 wells per pad)		**1.66 per well**	**2.87 per well**	**0.86 per well**

1. The operation disturbance for utilities assumes all utilities will be completed underground, and the land surface will be reclaimed so that no disturbance should remain except where noted.
2. It is assumed that each conventional oil and gas well will need product pipeline and produced water line from the well. In addition, some wells will need intermediate pipeline run from the field compressor to sales line.

TABLE 15
LEVEL OF DISTURBANCE FOR CBNG WELLS AND ASSOCIATED PRODUCTION FACILITIES

FACILITIES		Exploratory Well Disturbance (acres/well)	Construction Disturbance (acres/well)	Operation/ Production Disturbance (acres/well)
Well Pad (100-foot by 100-foot pad during drilling and construction, 200-foot by 200-foot pad during operation)		0.25	0.25	0.05
Access Roads/ Routes to Well Sites	Two-track	N/A	0.30	0.30
	Graveled	N/A	0.10	0.10
	Bladed	0.75	0.075	0.10
Utility Lines	Water	N/A	0.35	----[1]
	Overhead Elec.	N/A	0.20	0.20
	Underground Elec.	N/A	0.35	----
Transportation Lines	Low Pressure Gas	N/A	0.90	----
	Intermediate Pres. Gas	N/A	0.25	----
Processing Area	Battery Site	N/A	0.020	0.020
	Access Roads	N/A	0.15	0.15
	Field Compressor	N/A	----	0.02 (0.5 acres / 24 producing wells)
	Sales Compressor	N/A	----	0.005 (1.0 acres / 240 producing wells)
	Plastic Line	N/A	----	0.5[2]
	Gathering Line	N/A	----	0.25
	Sales Line	N/A	----	0.075
Produced Water Management	Discharge Point	N/A	0.01	0.002
	Storage Impoundment	N/A	0.3	0.25
Total Disturbance		1.0	3.25	2.0

1. The operation disturbance for utilities assumes all utilities will be completed underground, and the land surface will be reclaimed so that no disturbance should remain except where noted.
2. Plastic lines within the processing area are assumed to disturb an average corridor with of 25 feet.

Roads can be permanent or temporary, depending on the success of the well. The initial construction can be for a temporary road; however, it is designed so that it can become permanent if the well produces. Not all temporary roads constructed are rehabilitated when the drilling stops. A temporary road is often used as access to other drill sites. The main roads and temporary roads, require graveling to be maintained as all-weather roads. This is especially important in the spring. Access roads may be required to cross public lands to a well site located on private or state lands. The portion of the access road on public land would require a BLM right-of-way.

Most conventional wells are drilled from a fixed platform while the majority of CBNG wells are drilled using a truck-mounted rig. Site preparation generally takes about a week before the drill rig is assembled. For moderate depth oil wells drilling generally takes 2 to 4 weeks, although deeper wells may require longer drilling time because of the geologic formations encountered. Wells drilled from a platform require more surface preparation and cause disturbance to a larger area for the ancillary facilities. CBNG wells are usually drilled in under a week and site preparation is typically less than for conventional wells.

Approximately 1 to 4 acres are impacted by well site construction. The area is cleared of large vegetation, boulders, or debris. Then the topsoil is removed and saved for reclamation. A level area from 1 to 4 acres is then constructed for the well site, which includes the reserve pit.

The well pad is constructed by bulldozers and motor scrapers. The well pad is flat (to accommodate the drill rig and support equipment) and large enough to store all the equipment and supplies without restricting safe work areas. The drill rig must be placed on “cut” material rather than on “fill” material to provide a stable foundation for the rig. The degree of cutting and filling depends on terrain; that is, the flatter the site, the less dirt work is required.

Hillside locations are common, and the amount of dirt work varies with the steepness. A typical well pad will require a cut 10 feet deep against the hill and a fill 8 feet high on the outside. It is normal to have more cut than fill to allow for compaction, and any excess material is then stockpiled. Eventually, when the well is plugged and abandoned, excavated material is put back in its original place.

Reserve pits are normally constructed on the well pad. Usually the reserve pit is excavated in “cut” material on the well pad. The reserve pit is designed to hold drill cuttings and used drilling fluids. The size and number of pits depends on the depth of the well, circulating system and anticipated down hole problems, such as excess water flows.

Reserve pits are generally square or oblong, but may be irregular in shape to conform to terrain. The size of reserve pits for deeper wells can be reduced by the use of steel mud tanks. For truck-mounted drill rigs used in shallow gas fields, a small pit (called the blooie pit) is used. Most or all of the reserve pit is located in the cut location of the drillsite for stability. When the drillsite is completed, the rig and ancillary equipment are moved on location and drilling begins.

The reserve pit can be lined with a synthetic liner to contain pit contents and reduce pit seepage. Not all reserve pits are lined; however, BLM often requires a synthetic liner depending upon factors such as soils, pit locations, ground water and drilling mud constituents. The operator can elect to line the reserve pit without that requirement.

An adequate supply of water is required for drilling operations and other uses. The sources of water can be a well at the drill site or remote sources such as streams, ponds, or wells. The water is transported to the site by truck or pipeline. Pipelines are normally small diameter surface lines. The operator must file for and obtain all necessary permits for water from the state. On public lands an operator must have the BLM’s permission before surface water can be used.

9.3 Mitigation Measures

Mitigation measures are restrictions on lease operations, which are intended to minimize or avoid adverse impacts to resources or land uses from oil and gas activities. The mitigation measures listed in Table 8-5 would be applied to permits, leases or approvals granted by the land management agency. The list is not all inclusive, but presents the mitigation measures most often used in the Jackson Field Office Arkansas RMP area. The wording of the mitigation measure may be modified or additional measures may be developed to address specific conditions. Mitigation measures would be included as appropriate to address site-specific concerns during all phases of oil, gas and CBNG development.

9.4 Conditions of Approval

An approved application for permit to drill (APD) includes conditions of approval (COA), and Informational Notices which cite the regulatory requirements from the Code of Federal Regulations, Onshore Operating Orders and other guidance. Conditions of approval are mitigation measures which implement lease restrictions to site specific conditions. General guidance for COA are found in the BLM and U.S. Forest Service brochure entitled “Surface Operating Standards for Oil and Gas Exploration and Development” (USDI, BLM 1989) and BLM Manual 9113 entitled “Roads”.

9.5 Lease Stipulations

Certain Resources in the planning area require protection from impacts associated with oil and gas development. The specific resources and methods of protection are contained in lease stipulations. Lease stipulations usually consist of no surface occupancy, controlled surface use, or timing limitations. A notice may be included with a leased to provide guidance regarding resources or land use. While actual wording of stipulations may be adjusted at the time of leasing, the protection standard described will be maintained.

9.6 Total Disturbances

The disturbances for the RFD scenario over the next 10 years have been calculated and are displayed in Tables 16 and 17. Table 16 address the disturbances from exploration and construction activities for types of gas wells anticipated to be developed in the northwest central portion of the state. Estimates for horizontal gas and deep gas, CBNG and multiple horizontal wells from single pads as well as horizontal CBNG wells have been extrapolated. The total disturbances for all predicted gas wells are estimated at 63,993 acres. Disturbance from federal mineral development would be 15,076 acres of which 13,517 acres would be on USFS lands. The remaining federal disturbance (1,559 acres) would be on military sites, national park lands, and USFWS refuges. The disturbance to state and fee lands would be 1,039 acres and 52,517 acres respectively.

Table 17 depicts the residual disturbance by well type remaining after appropriate mitigation measures and site restoration or rehabilitation activities have taken place. The total residual disturbance from anticipated development activities is 22,006 acres of which 4,832 would be from federal mineral development. The federal disturbances would affect 4,331 USFS acres and 500 acres of various surface agencies. State and fee residual disturbance would be 331 and 16,844 acres respectively.

The mitigation of initial exploration and construction disturbances would equal nearly 47,339 acres. Mitigation measures would account for remediation of 10,244 federal acres, 699 state acres, and 35,673 fee acres.

TABLE 16
PREDICTED DEVELOPMENT AND SURFACE DISTURBANCE (EXPLORATION AND CONSTRUCTION) FOR GAS WELLS

Well Type	Total Wells Drilled	Dry Holes	Disturbance per Dry Hole	Total Dry Hole Disturbance	Federal Producing Wells	Disturbance per Federal Well	Total Federal Disturbance	State Producing Wells	Disturbance per State Well	Total State Disturbance	USFS Producing Wells	Disturbance per USFS Well	Total USFS Disturbance	Fee Producing Wells	Disturbance per Fee Well	Total Fee Disturbance	Total Producing wells	Total Disturbance
Gas – horizontal	7,755	155	3.43	531.65	172	6.90	1,186.80	114	6.90	786.60	1,501	6.90	10,356.90	5,813	6.90	40,109.70	7,600	52.,971.65
Gas – horizontal (4 from single pad)	2,585	52	1.66	86.32	57	2.87	163.59	38	2.87	109.06	500	2.87	1,435.00	1,938	2.87	5,562.06	2,533	7,356.03
Gas – deep	1,250	25	3.96	99.0	28	6.71	187.88	18	6.71	120.78	242	6.71	1,623.82	937	6.71	6,287.27	1,225	8,318.75
Gas – shallow	0	0	2.43	0	0	4.79	0	0	4.79	0	0	4.79	0	0	4.79	0	0	0
CBNG	70	2	1.0	2	2	3.25	6.5	2	3.25	6.5	10	3.25	32.50	55	3.25	178.75	71	226.25
CBNG – horizontal	70	1	3.43	3.43	2	6.9	13.8	1	6.9	6.9	10	6.9	69	55	6.9	379.50	69	472.63
Total	11,730	235		722.40	261		1,558.57	173		1,029.84	2,263		13,517.22	8,798		52,517.28	11,495	69,345.31

Assumptions:

Disturbance per well includes the well pad plus incremental roads, utility lines, transportation lines, processing equipment areas, and produced water management as outlined in Tables 11, 12, 13, 14, & 15 for exploration.

TABLE 17
PREDICTED DEVELOPMENT AND RESIDUAL SURFACE DISTURBANCE (PRODUCTION) FOR GAS WELLS

Well Type	Total Wells Drilled	Federal Producing Wells	Disturbance per Federal Well	Total Federal Disturbance	State Producing Wells	Disturbance per State Well	Total State Disturbance	USFS Producing Wells	Disturbance per USFS Well	Total USFS Disturbance	Fee Producing Wells	Disturbance per Fee Well	Total Fee Disturbance	Total Producing wells	Total Disturbance
Gas – horizontal	7,755	172	2.21	380.12	114	2.21	251.94	1,501	2.21	3,317.21	5,813	2.21	12,846.73	7,600	16,796.00
Gas – horizontal (4 from single pad)	2,585	57	0.86	49.02	38	0.86	32.68	500	0.86	430.0	1,938	0.86	1,666.68	2,533	2,178.38
Gas – deep	1,250	28	2.24	62.72	18	2.24	40.32	242	2.24	542.08	937	2.24	2,098.88	1,225	2,744.00
Gas – shallow	0	0	1.81	0	0	1.81	0	0	1.81	0	0	1.81	0	0	0
CBNG	70	2	2.0	4	2	2.0	4	10	2.0	20	55	2.0	110	71	138
CBNG – horizontal	70	2	2.21	4.42	1	2.21	2.21	10	2.21	22.1	55	2.21	121.55	69	150.28
Total	11,730	261		500.28	166		331.15	1,328		4,331.39	7,264		16,843.84	9.006	22,006.66

Assumptions:

Disturbance per well is the residual disturbance remaining after the mitigation measures have been implemented.

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Fayetteville Shale Area Central Map - http://www.state.ar.us/agc/fscentral.pdf

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APPENDIX A

ARKANSAS GENERAL RULES

B-3: Spacing of Wells

B-40: Authorization for Director or Production and Conservation to Administratively Approve Applications for Exceptional Well Locations

B-43: Establishment of Drilling Units for Gas Production from Conventional and Unconventional Sources of Supply Occurring in Certain Prospective Areas Not Covered by Field Rules

APPENDIX B
FIELD RULE SUMMARIES

North Arkansas

South Arkansas